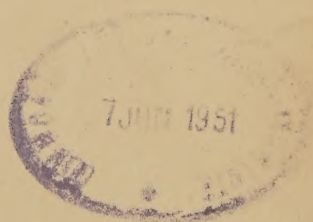


EMPIRE COTTON GROWING CORPORATION

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EXPERIMENT STATIONS
SEASON 1949 - 1950



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**PROGRESS REPORTS FROM EXPERIMENT
STATIONS, SEASON 1949-1950.**

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FOREWORD

BY

J. B. HUTCHINSON.

In the season under review, the Nyasaland station experienced disastrous floods, and the Lake Province of Tanganyika had a difficult time, largely owing to the aftermath of food shortages. Larger crops than usual were obtained in Eastern Tanganyika and Northern Nigeria. South Africa planted a larger acreage than usual, but pest attacks were heavy, and yield per acre consequently disappointing.

Crop Husbandry.

Problems of land use are most pressing in the West Indies, where large populations have to make a living on small islands, and interesting work on the reclamation and utilisation of steep hillslopes is in progress, along with experiments on the use of rotations allowing more intensive cropping of the land. Land use in Africa is bound up with the problem of the maintenance of soil condition under arable cultivation and the use of resting leys for soil improvement. In Tanganyika, data from Ukiriguru hill sands show substantial improvements in yield following resting treatments in a number of trials. In the first year after opening from tumbledown fallow, however, a depression was recorded, and this may be compared with the note from Samaru, in northern Nigeria, that land freshly broken from grass gave lower yields than old established arable.

Fertiliser trials are for the most part of local significance, and should be interpreted in terms of local soil conditions, but data on response to nitrogen are of general interest. The intimate relation between water supply and nitrogen status is shown by Queensland data, and responses to nitrogen in fertiliser trials elsewhere should be studied in terms of the effects of soil moisture on the accumulation of nitrate or its removal by leaching. The importance of timely planting is emphasised in several reports, and there can be no doubt that the interrelations of moisture supply and nitrogen status are among the dominant factors in determining optimum sowing date.

Much remains to be learnt of the moisture relations of the soil and their effect on the cotton crop. Intensive rain is a very important factor in soil erosion—in Queensland a rate of 0.40 in. per hour or more is regarded as erosive rain—and is largely wasted in run-off. The effect of such conservation methods as tie-ridging on soil moisture needs investigation in the light of data on rainfall intensity and the distribution and frequency of storms.

Mechanical cultivation is being developed in Tanganyika and Nyasaland, and mechanical picking in Queensland and Southern Rhodesia, where mechanical cultivation is already well established. In Nyasaland the difficulties of the change-over from the hoe to the

tractor plough are considerable, and the importance is emphasised of adequate preparation of the land for mechanisation, by thorough clearing and stumping. Considerable advantages in terms of timely planting of the crop are anticipated from the mechanisation of land preparation in the Lake Province in Tanganyika. Mechanical picking is still in the experimental stage. In Queensland only 73% of the crop on very vegetative plants was taken by the picker, and in Southern Rhodesia the first experiments showed what elaborate organisation and equipment will be necessary to produce machine-picked lint in a marketable form.

Entomology.

The reports record the entry of commercial firms into the field of cotton pest control in South Africa. All available evidence emphasises the need for the fullest understanding of the bionomics of pests and of associated insects before insecticidal control can be undertaken with good prospects of success. In Eastern Tanganyika, for instance, the use of insecticides in a trial was followed by a serious attack of aphis, believed to have resulted from the destruction of predators. In Northern Nigeria, hopes of an economic attack by insecticides on Red bollworm depend upon confining the initial outbreak to a short period by plant sanitation methods. Similarly, the timing and intensity of American bollworm outbreaks depend on the timing of fruiting in alternative hosts, both cultivated and wild, and any insecticidal control on an economic scale would depend on a careful planning of the cropping system to minimise the outbreak and to confine it to a limited and predictable period.

Important data are available from Nigeria, Nyasaland and Tanganyika on Red bollworm. Its bionomics in Nigeria have now been made clear, and an intelligent attack on the insect thus becomes possible. The failure of a non-cotton year to reduce Red bollworm infestation in an experimental area in Nyasaland may be noted. A cotton-free zone 5 miles in radius was ineffective in reducing egg laying at the centre in the following season, and it was concluded that the flight range of the moth must exceed 5 miles. Red bollworm larvae collected from *Gossypioides kirkii* in Tanganyika yielded a moth which was classified as *Diparopsis* but probably not *castanea*.

Plant Pathology.

Verticillium wilt appears to be spreading in South Africa, and developments will be followed with interest in view of the possibility that this disease may become more serious in other parts of Africa.

Bacterial blight, or blackarm, has been recorded as important at many stations. Though the ultimate solution must be the breeding of resistant varieties, information on the pathogenicity and epidemiology of the disease is much to be desired, both as a prerequisite to the design of control measures, and as a guide to those engaged in breeding for resistance.

Plant Breeding.

The outstanding feature of the plant breeding sections of the reports is the interest in a wider range of material. In this respect, Barberton is the most advanced, with a derivative of a cross (A2106) already in general cultivation, and others following on. In the Sudan, "BAR" stocks derived from gene transference work are in an advanced stage of multiplication, and would have been in greater bulk but for the need for caution in assessing the quality of all new material. In the West Indies, hybrid stocks have been brought to the quality level of the superfine V135, and have provided material for tests of better quality varieties to replace MSI in Antigua and Nevis. In the Lake Province of Tanganyika, a degree of blackarm resistance is needed beyond that to be found in East African stocks, and hybrids are to be made with "Albar," which is the name given to highly resistant lines selected at Shambat and Namulonge out of Nigerian Allen.

From the Sudan, good progress is reported in transferring jassid resistance to Sudan Egyptians. In the longer range genetic work in progress there, the acquisition of almost all the remaining wild species of the genus *Gossypium* may be noted, and also the successful synthesis of an allopolyploid from *G. arboreum* $\times$ *G. raimondii*, the putative parents of the New World cottons.

Seed multiplication and distribution are discussed in the Tanganyika and Nigerian reports. In Tanganyika UK46 now covers nearly the whole of the Lake Province, and is being followed by UK48. The wisdom of putting out a mixture of several good strains, and following it with a better mixture as one becomes available, has been amply demonstrated. The method has the advantages of an early realisation of the improvements available in the breeding plots, flexibility, and ease of replacement by something better without disturbing the market. In Nigeria attention has been paid to the problem of getting the improved strain, 26C, out over the whole of the area as soon as possible. It is now estimated that in future complete replacement can be achieved in 7 years.

Quality problems.

The success of early sowing and wide spacing in improving grade in the Sudan Gezira is important, and has been made possible by the breeding of cottons sufficiently resistant to blackarm to be planted in the period when climatic conditions favour the spread of the disease. The demonstration in Antigua that for good grade, seed cotton should be picked as soon as possible and should not be tightly packed, is of general importance for rain fed areas.

Conclusion.

An analysis of these reports by subjects tends to obscure the unity of any study of the growth and productivity of a crop plant. The cotton specialist is of necessity involved in problems belonging to several scientific disciplines, and it is a feature of these reports that it is not possible to draw distinctions between crop husbandry, pest and disease studies, and plant breeding without losing some of the essential merit of the work recorded.

COTTON RESEARCH STATION, NAMULONGE.

PROGRESS REPORT FOR THE SEASON 1949-1950

BY

J. B. HUTCHINSON AND H. L. MANNING.

Sowing	...	Early June and July.
Flowering	...	Late August to October.
Picking	...	Late November to February.

INTRODUCTION.

During the year 1949-50 considerable progress was made with the development and building of the station, but the research programme was limited to breeding work with BP.52 and observation plots of the extensive collection of Upland cottons.

By October, 1950, ten members of the European staff were in residence, and one more and an insecticide expert on the staff of E.A.A.F.R.O. were expected almost immediately. The main laboratory was practically complete, and accommodation became available in it in time for the 1950-51 season, by the beginning of which seventy acres of land had been cleared and brought into cultivation. Sweet potatoes, maize and beans were planted as cleaning crops on the earlier cleared land, and 49 acres were put into cotton between the end of June and mid-August. The wide spread of planting dates was unavoidable in the existing state of development of the station, but it had the advantage of providing a demonstration, on measured areas, of the effect of planting date on crop development. The early cotton, mainly BP.52 breeding plots, got away to an excellent start. With late plantings, difficult moisture conditions were experienced, and establishment and early development were correspondingly handicapped. The cotton areas thus provide an excellent illustration of the advantages of planting at the end of the main rains as against planting during the break of the second rains. With the good and reliable moisture conditions early on, the crop started well and was able, in the comparatively dry weather of July, to get well ahead of any weed growth. July and August plantings, on the other hand, made a poor start, and in some cases needed heavy supplying. The September rains caused rapid weed growth and hindered weeding, and the late cotton suffered considerably from weed competition.

METEOROLOGY.

A critical assessment of the climate of Namulonge will be possible only when comprehensive meteorological data have been collected over a number of seasons. Nevertheless, from rainfall records which have been kept since 1947, an estimate of the probable mean can be

derived by the use of a square root transformation of monthly totals. The reconverted means suggest that the cotton planting rains at Namulonge are intermediate between those of the Government stations at Kawanda and Bukalasa. Rainfall and some temperature data, for Namulonge and Kawanda, are summarised in Table 1 for the period January, 1947 to May, 1950.

TABLE 1.

SUMMARY OF METEOROLOGICAL DATA FOR NAMULONGE AND KAWANDA. RAINFALL FOR JANUARY 1947—MAY 1950.
AVERAGE TEMPERATURE NOVEMBER 1949—MAY 1950.

Month.	Namulonge.			Kawanda.			Remarks.
	Mean* Rainfall.	Rainfall 1949-50.	Average† Temp. °F.	Mean* Rainfall.	Rainfall 1949-50.	Average† Temp. °F.	
June	2.57	3.07	—	2.89	3.12	69.6	Cotton Season.
July	3.15	3.60	—	1.81	2.21	69.0	
August	3.66	3.95	—	3.03	2.68	69.7	
September	3.54	1.17	—	4.94	1.67	70.0	
October	3.62	4.87	—	3.70	4.05	71.3	
November	2.13	2.05	74.4	2.00	1.28	72.7	
December	2.16	4.24	72.1	2.67	3.53	73.8	
January	2.39	3.42	73.6	1.87	2.87	72.0	
February	2.85	4.56	73.6	2.32	2.40	72.0	
	26.07	30.93	—	25.23	23.81	—	
March	4.74	7.00	73.7	2.53	3.88	72.7	Food Crops Season.
April	7.72	9.02	72.5	6.34	6.91	71.3	
May	5.36	7.74	73.2	4.42	6.33	70.6	
	17.82	23.76	—	13.29	17.12	—	
Totals	43.89	54.69	—	38.52	40.93	Annual = 71.2	

* From square root transformation.

† (Mean Max. + Mean Min.)/2.

PLANT BREEDING AND GENETICS.

The year under review was the first in which a breeding programme was carried out at Namulonge. With the staff and facilities available, only a limited amount of work could be undertaken, but a range of genetic material was planted as well as the BP.52 breeding stocks that had been under Mr. Manning's charge at Kawanda during the two previous seasons.

Genetic material: The whole of the collection of annual forms of *G. hirsutum* (Uplands and their relatives), and a representative range of other races of the same species, were planted in small plots at Namulonge in the third week of July. In addition, breeding stocks of hybrid origin designed for the transfer of staple length to MU.8 were sown at the same time, together with small plots of East and South African strains for comparison.

Control plots of BP.52B were planted at frequent intervals among the type collection, and the most striking feature of the experiment was the scarcity of types from outside Uganda that could compete with BP.52 in yield. Moreover, though BP.52 in Uganda has a long growing period, there were few types even among those that are early croppers in other countries, that were earlier than BP.52 when grown beside it. The best cropping material in the collection was undoubtedly the Cambodia type of South India, followed by Indian Peninsula strains of mixed Cambodia and Indian Upland ancestry, and by U.4 stocks from Southern Rhodesia.

Bacterial blight was severe in most *G. hirsutum* material of American origin, and practically killed out some *punctatum* and *palmeri* lines. *Lygus* did some damage, and there was evidence that the Cambodias suffered less than most other types, and the Pakistan Uplands suffered more.

The MU.8 hybrid staple length material was attacked by wilt, and it appears probable that the wilt susceptibility of MU.8 will limit its usefulness as a parental stock. Some promising selections were taken, and bulks were made of the best progenies.

BP.52 Breeding Stocks: Work on BP.52 falls into two parts. One is the production of a relatively uniform nucleus stock ("Modal Bulk") as a standard of comparison, and for use as a basis for the seed supply work of the Agricultural Department. The second is the exploitation of the genetic variability of the variety by selection to give superior lines.

(a) *Modal Bulk*. A modal bulk is made up by the determination of mean values of the variety for the more important characters, and then discarding all material deviating from any one of these values by plus or minus an amount exceeding the standard deviation.* By repeating the process of concentration round the variety characteristics for several years, a steady increase in uniformity may be expected without change in character. The establishment of such a modal bulk was made the first objective when the BP.52 breeding work was taken over, not in the expectation of producing a superior stock, but to establish a stable, uniform typical BP.52 that could be used as a standard of comparison in future breeding and testing work. The initial material consisted of 437 plants grown at Kawanda in 1947-48, from which discards were made on lint length and lint index, leaving 211 plants as parents of 1 MB. The history of the current Modal Bulk showing the extent of the variability in measured characters in the three seasons, is summarised in Table 2.

TABLE 2.
COEFFICIENTS OF VARIABILITY FOR SEED COTTON CHARACTERS OF MODAL BULKS IN SUCCESSIVE YEARS.

Year	1947-48	1948-49	1949-50
Generation	Original	1 MB	2 MB
No. of Plants Examined	437	177	171
<i>Lint Index—</i>			
Mean Value	4.64	5.22	4.48
C.O.V.	14.0%	9.0%	10.5%
<i>Seed Weight—</i>			
Mean Value	—	10.47	10.41
C.O.V.	—	8.7%	8.0%
<i>Lint Length—</i>			
Mean Value	30.27	29.47	31.48
C.O.V.	6.0%	5.4%	5.2%
No. of plants selected	211	177	171
		Grown at Kawanda.	Grown at Namulonge.
Yield Excess of Selected Plants over Population as a Whole.			
	7.8%	3.2%	3.1%

The criteria for modal bulk selection were seed cotton and lint characters, and it will be seen that variability has decreased except

*The system is known in the Sudan as filtering.

in lint index in the last season. This may be a chance deviation or a seasonal effect, and precise information on the rate of change of variability under this type of selection will only be obtained by continuing the process considerably longer. Some fluctuation occurred in mean values, and the significance of this also may be expected to become apparent when a longer run of records is available.

An unexpected consequence of selecting for modal values has been that in each year plants exceeding the mean yield of the population have been retained as parents. This excess amounted to nearly 8% in the first year, and to 3% in each of the subsequent years. Though desirable in itself, this yield increment complicates the use of modal bulk as a standard of comparison.

(b) Progeny Row Breeding. In breeding stocks, variability is of the greatest importance, as it is only in variable material that response to selection may be expected. When superior lines have been selected and pass out into the pedigree seed nucleus, however, variability ceases to be desirable, and the improvement of uniformity by the modal bulk technique becomes appropriate.

The importance of the progeny row system lies in its suitability as a tool for the estimation of the variability on which the prospects of improvement depend, and for the planning of selection to the best advantage. In previous reports it was shown that considerable variation exists in BP.52 in the important components of yield. At least two of the three fundamental yield components were found this season to have high genetic variability between progenies in strains. At the same time in one important character—bolls per plant—no appreciable genetic variability was detected. A number of detailed records were kept and some of these are summarised in Table 3, which also shows that some of the differences recorded were of a high order.

TABLE 3.

SUMMARY OF MORPHOLOGICAL AND SEED COTTON CHARACTERS FOR BP.52 STRAINS GROWN AT NAMULONGE 1949-50. DATA FROM A 7 × 7 LATTICE SQUARE EACH STRAIN CONTAINING 4 FUZZY PROGENIES OF 40 PLANTS AT 3 FT. × 2 FT. PLANTED JUNE 7TH, 1949.

Line.	Strain.	Days to flower.	Lygus Damage Index. 128 Days.	Black-arm Lesions 140 Days.	Plant height at 160 Days.	Components of Yield.				Ginning Out-Turn.	Seed Weight.
						X ₁ Bolling Index.	X ₂ Seeds/Boll.	X ₃ Lint/Seed.	Y Lint/Plant.		
C (47) 1	C (48) 2	85.5	3.3	3.8	45.0	20.8	29.4	4.90	26.8	31.9	10.48
C (47) 2	C (48) 4	81.4	3.1	3.3	44.1	19.4	31.9	4.29	26.1	29.8	10.15
	C (48) 7	83.0	3.4	2.8	43.5	17.5	31.5	4.38	24.4	30.5	10.02
	C (48) 8	82.8	3.0	2.7	42.5	21.9	32.0	4.38	28.1	30.5	9.95
C (47) 3	C (48) 10	87.5	3.6	3.4	45.8	16.8	31.6	4.82	23.3	29.3	11.65
	C (48) 12	86.2	3.5	3.0	46.0	20.0	28.1	5.12	26.5	32.6	10.60
	C (48) 13	85.6	3.3	2.7	44.1	18.7	31.7	4.91	24.7	31.6	10.55
C (47) 9	C (48) 29	83.9	3.4	3.8	44.8	23.1	29.8	4.82	26.3	32.9	9.80
C (47) 18	C (48) 34	86.7	3.5	2.8	45.9	20.9	31.5	5.16	28.3	33.3	10.30
C (47) 22	C (48) 36	86.0	3.6	3.4	49.9	20.6	32.9	3.78	22.9	27.1	10.15
C (47) 23	C (48) 37	89.1	3.2	2.0	41.5	22.6	31.3	3.96	23.8	29.5	9.60
Modal	Bulk	86.1	3.6	3.6	44.0	19.0	31.8	4.85	25.0	31.3	10.70

Values for Variance Ratio.

Due to											
Lines	...	...	18.15**	3.15*	12.01**	—	3.41*	7.84*	70.54***	4.13*	—
Strains	...	...	1.24	3.31*	1.77	—	3.15*	8.36*	2.55*	3.14*	—
Progenies	...	...	2.05**	1.25	1.46	—	—	2.11**	3.77***	1.23	—

*P = 0.05.

** = 0.01

*** = 0.001.

Strains of the C(47)2 line flowered appreciably earlier than all others. *Lygus* leaf damage per plant was estimated on the scale 1 to 5 in an attempt to assess possible differences in degree of susceptibility of BP.52 lines. The table shows that some differences between strains in lines were detected but that differences between progenies in strains were not statistically significant. Important differences were recorded in the damage done by bacterial blight (*Xanthomonas malvacearum*). Seed has been sent to Dr. Knight at Shambat, and records of parallel blackarm resistance gradings from Shambat and Namulonge are being collected. It is already apparent that there is good general agreement between them, and selection for resistance can therefore be carried on with some confidence. Of greater significance is the analysis of the components of yield, which showed that lint per seed was of considerable importance. Therefore the high lint index strains of the C(47)3 line offer considerable scope for yield improvement. One of these has, in fact, given a consistently good performance in the Small Bulks trial.

Estimates of genotypic and phenotypic variances and covariances are given in Table 4 for yield components and yield alone.

TABLE 4.

MEAN SQUARES AND MEAN PRODUCTS FOR 44 FUZZY BP.52 PROGENIES WITH ESTIMATES OF GENOTYPIC AND PHENOTYPIC VARIANCES AND COVARIANCES.

WHERE X_1 = BOLLING INDEX; X_2 = SEEDS PER BOLL; X_3 = LINT PER SEED; Y = LINT PER PLANT.

Variation due to ...	d.f.	X_1^2	X_1X_2	X_2^2	X_1X_3	X_2X_3	X_3^2	X_1Y	X_2Y	X_3Y	Y^2
Between Progenies in Strains ...	33	18.36	+0.497	5.040	-0.815	-3.079	30.13	10.570	+0.303	+9.788	18.39
Error ...	129	19.24	+0.846	3.314	-4.042	-1.039	7.98	10.842	+0.112	+3.414	14.95
g_{ii} and g_{ij} ...	—	0	-0.089	0.432	+0.817	-0.516	5.606	-0.069	+0.048	1.613	0.871
t_{ii} and t_{ij} ...	—	4.590	+0.124	1.259	-0.204	-0.770	7.533	+2.643	+0.076	2.447	4.598

The additive portion (g_{ii}) of total genetic variation (t_{ii}) is shown to be highest for lint per seed (X_3), resulting in heavy weighting to this character in the subsequent selection index. The selection pressure measured by the proportion retained (6/44 progenies) and the genetic variability indicated that a selection advance of from 4 to 6 per cent. should be expected for all progenies over the population from which they came.

Yield advance of all progenies over the Modal Bulk was about 2.5 per cent. As the Modal Bulk itself (see above) has been improved at a rate of approximately 3 per cent. per annum, the observed improvement is in satisfactory agreement with expectation.

(c) Trials of Bulks of Selected Progenies: Small bulks from four of the best progenies of the previous season were compared in a

randomised block trial with 6 replications of 1/60th acre plots. Data are summarised in table 5.

TABLE 5.
SMALL BULK STRAIN TRIAL.
6 REPLICATIONS WITH PLOTS 1/60TH ACRE AT 3 FT. × 2 FT. SPACING,
PLANTED JUNE 9TH, 1949.

STRAIN	Cumulative Seed Cotton/acre at Dates.							G.O.	Lint Index.	% Stains.	Clean lint/acre.
	23/11/49	2/12/49	15/12/49	3/1/50	13/1/50	26/1/50	9/2/50				
C (48) 4	186	324	524	704	796	1010	1085	30.6	4.46	9.5	300
C (48) 12	134	275	499	781	935	1150	1202	33.3	5.65	9.6	362
C (48) 13	144	277	471	688	786	988	1057	32.1	5.20	11.9	299
C (48) 37	142	237	424	650	785	996	1044	30.7	4.22	10.0	288
M.B. ...	161	310	506	692	778	974	1033	31.5	5.00	11.2	289

Significance of Differences in Lint/acre.

C (48) 12	C (48) 4	C (48) 13	M.B.	C (48) 37
-----------	----------	-----------	------	-----------

Cumulative yields for most strains on 3.1.50 (209 days from planting), which would be the third effective commercial picking, were about 700 lb. of seed cotton and for the highest yielding strain nearly 800 lb. Subsequent pickings on 13.1.50 and 26.1.50 each yielded between 150 and 200 lb. seed cotton. With prevailing prices for seed cotton, pickings of as low as 100 lb. per acre per pick are well worth while.

The two promising strains in this trial, C(48)4 and C(48)12, have rather different characteristics. C(48)4, which is little better in yield than Modal Bulk, was judged on hand examination to be a high quality type. The large balled high ginning outturn C(48)12 strain outyielded the Modal Bulk by more than 25% of lint per acre. In quality it was regarded as approximately equal to Modal Bulk. Small scale spinning tests were carried out by the Shirley Institute on breeding stocks of the 1947-48, 1948-49 and 1949-50 seasons, and the count strength products and yarn appearance gradings are given in Table 6.

TABLE 6.
COUNT × STRENGTH PRODUCTS AND YARN APPEARANCES OF BP.52 BREEDING STOCKS OVER THREE SEASONS.
COUNTS SPUN 40S. TWIST FACTOR 3.75.

1947/48.	1948/49.	1949/50.
C (47) 1 = 2341 F. ...	C (48) 2 = 2254 F. ...	C (49) 3 = 2272 F.
C (47) 2 = 2400 G. ...	C (48) 4 = 2297 G. ...	C (49) 5 = 2262 F.G.
	C (48) 8 = 2165 M. ...	C (49) 14 = 2231 F.G.
C (47) 3 = 2484 F.G.	C (48) 12 = 2368 F.G.	C (49) 16 = 2148 F.G.
	C (48) 13 = 2324 F. ...	C (49) 21 = 2098 F.G.
C (47) 18 = 2428 F.G.	C (48) 29 = 2306 F.G.	C (49) 24 = 2199 G.
	C (48) 34 = 2456 G. ...	C (49) 25 = 2248 F.G.
C (47) 22 = 2511 F.G.	C (48) 36 = 2574 F.G.	C (49) 30 = 2205 F.G.
C (47) 23 = 2272 F. ...	C (48) 37 = 2224 F.G.	C (49) 34 = 2184 G.
		C (49) 35 = 2348 F.G.
		C (49) 39 = 2471 F.
		C (49) 42 = 2273 G.
Mean of 23 2374.5	Mean of 12 2335.2	Mean of 12 2244.9
Kawanda.		Namulonge

Yarn appearance :

M = moderate.

F = fair.

FG = fairly good.

G = good.

No Modal Bulk controls were included in the small scale tests, but the general level of 2,200 in count strength product is judged satisfactory. On this criterion it will be seen that both C(48)4 and C(48)12 gave yarn of satisfactory strength, but that C(48)4 was superior in appearance. The drop in count strength product in derivatives of C(48)12 in 1949-50 emphasises the need for caution in selecting for high lint index.

Bulk lots of Namulonge-grown 2MB, BC.66 and BP.52B (control) were sent to the Raw Cotton Commission by the Uganda Lint Marketing Board, and samples were tested by the Shirley Institute and the Lancashire Cotton Corporation. Test results and the Raw Cotton Commission's grader's opinion are summarised in Table 7.

It will be seen that all three lots were regarded as good of their type, except for a rather large proportion of short hairs.

TABLE 7.
SUMMARY OF TEST REPORTS ON NL.50, BC.66 AND BP.52B.

Character.	NL.50-2.MB.	BC.66.	BP.52B.
Effective length	42.3	42.0	42.5
Short fibre	21.6	22.1	24.0
Mean hair weight	142.7	129.5	148.8
Maturity count	39.6	38.7	46.6
Standard hair weight	164	151	165
Maturity percentage	85.8	86.8	90.0
Percentage clean cotton	96.3	96.0	96.4
<i>Small Scale Spinning Test.</i>			
C × S (40s)	2089	2098	2289
Yarn appearance	fair little nep.	moderate neppy.	fair little nep.
<i>Comments on Hair Characters.</i>			
L.C.C. Testing House	“ These results are the best obtained here from samples of AR/Uganda cotton.” The short fibre percentage was high, especially for BP.52B.		
R.C.C. Grader	NL.50 and BC.66 very fine but irregular. BP.52B longer than NL.50 but irregular.		

Namulonge Unit of District Variety Trial : This season Namulonge was added to the list of places where 5 × 5 Latin Square District variety trials are grown. The varieties grown were B.181 and S.47 from Serere seed, and the BP.52 types, BC.66, BP.52B and Modal Bulk from seed grown at Kawanda. The Namulonge trial was planted early in July at spacing 3 ft. × 1 ft. Yield and blackarm data are summarised in Table 8. The extent of blackarm infection was measured at 8 weeks by taking the percentage of plants with one or more severe lesions on the main stem.

TABLE 8.
SUMMARY FOR THE DISTRICT VARIETY TRIAL AT NAMULONGE.
PLANTED 2ND JULY, 1949.
PLOT SIZE 1/60TH ACRE. SPACING 3 FT. X 1 FT.

Variety.	Cumulative Seed cotton per acre.						G.O. %	Lint Acre.	X.M.* Count.
	17/12/49	4/1/50	16/1/50	27/1/50	10/2/50	27/2/50			
BP.52 { 2 MB ...	327	594	804	1055	1128	1155	31.3	361	81.4
BP.52B ...	220	472	664	896	980	1011	32.3	316	74.2
BC.66 ...	293	508	678	924	1000	1021	31.2	320	58.8
B.181 ...	130	440	704	1010	1130	1222	31.5	382	90.4
S.47 ...	215	567	792	1000	1085	1108	31.2	346	89.6

*Percentage of plants with one or more severe X.M. lesions on main stem.

Significance of Differences for Lint/acre.

B.181 S.47 2MB BC.66 BP.52B

The cumulative picking curves of the three BP.52 strains and S.47 are similar, and the four strains maintained practically the same order throughout. The relation between the curves for the BP.52 types and B.181 resembles that between the regression lines of yield on fertility level for these two varieties (see Annual Report 1946-47, P.91). B.181, which is the lower yielder in the early pickings and under low fertility conditions, surpasses BP.52 in yield at high yield levels, or at the end of the season if conditions have favoured long continued fruiting. Modal Bulk, though giving a picking curve similar to that of BP.52B, maintained a higher yield level than the latter throughout. In consequence, it exceeded B.181 by a greater amount in the early pickings, and was only outyielded by it in the end by 67 lb. in the very last picking.

PROGRAMME OF WORK.

INTRODUCTION.

Cotton research in Africa is dominated by the fact that the crop is a comparatively new introduction. During the forty years or so that have elapsed since the Upland cottons were brought to the rain-fed tracts of Africa a continuous process of adjustment of the crop to the new environment has gone on, partly by trial and error in the field, and in large measure by investigations at experiment stations and in field trials by Departments of Agriculture and by the Empire Cotton Growing Corporation. In consequence, cotton is now firmly established as a major cash crop over wide areas. The more immediate problems of establishment of the crop having been solved, further progress will be increasingly dependent on carefully planned experimentation and research. It is the function of the Cotton Research Station, Namulonge, to undertake some of the longer range investigations now required.

Considering first cotton entomology, much progress towards minimising pest damage has been made by methods which depend on detailed knowledge of the ecology of the pests and their wild and cultivated hosts, and on the place of the latter in the farming system.

This knowledge is fundamental to a proper attack on pests, from whatever angle. But control by evasion is distinctly limited by the place of cotton in African peasant farming, especially in the rain-fed areas, and we must look to other methods. The first of these is the search for resistance, already very successful in certain cases. The second is direct action by insecticides. Hitherto this has been impracticable, but with the introduction of new and more potent insecticides, and with the expected developments in patterns and methods of African farming, the outlook is more hopeful, and research on the technique of direct control is to-day an urgent need.

In plant pathology the epidemiology of bacterial blight (*Xanthomonas malvacearum*) is imperfectly understood, and though the principle of control by the breeding of resistant varieties is generally accepted, much patient research in both pathology and genetics is necessary before practical control can be achieved.

In plant breeding, great advances have been made by the selection of locally acclimatised forms, and in particular of types resistant to the jassid pest and partially resistant to bacterial blight. Recent genetic research has, however, indicated scope for much greater improvement in crop performance. Except in the Congo, the African Uplands are all derived from a very limited selection of the older varieties of the American Cotton Belt. The range of genetic material may be widened by hybridisation with such stocks as the acclimatised Uplands of India, lines from West Africa carrying very high resistance to bacterial blight, and modern American varieties with a high potential crop production.

Cotton physiology in Africa is in its infancy. Many African cotton varieties are inefficient crop producers, and though this is partly a matter of pest and disease damage, climatic factors are probably equally important. Water and nutrient supply, temperature and solar radiation are basic factors in the determination of both crop production and lint quality, and little is known of their mode of action in either case.

Crop husbandry problems are under intensive study at all experiment stations. Crop rotations, ley farming, the use of livestock in mixed farming and the introduction of mechanical cultivation are being widely tested. The main interest of the Cotton Research Station in such matters lies in their bearing on the problem of fitting the cotton crop into its place in African agriculture, and they will be studied primarily from that point of view. The fundamental obligation of a good farmer to maintain the fertility of his farm is, of course, recognised, and in doing this every effort will be made to use methods which a peasant farmer may eventually emulate.

CROP HUSBANDRY.

The Namulonge estate amounts to 2,240 acres, of which about 400 acres are swamp, about 100 acres are occupied by housing areas

and adjacent land that will be left under permanent pasture, and perhaps another 200 acres are steep and stony slopes unsuitable for tillage. It is hoped in time to get 1,500 acres under cultivation, and in conformity with the recommendations of the Agricultural Department, a system of ley farming will be initiated which will entail alternately three years cropping and three years grass rest. Short grasses will be used for the resting leys, *Chloris gayana* and naturally regenerating *Panicum maximum* being the most important, at least in the first instance. A herd of N'ganda cattle has been started, and though numbers are small (about 70 head), it is intended to increase it greatly as opportunity offers, to make use of the leys. Development of the land can only proceed slowly until the building programme is complete. About 70 acres were under the plough by 1st July, 1950.

Namulonge is situated in rolling country, and the farming system to be adopted is determined by the topography of the land, and by the necessity for soil and water conservation. Fields are laid out in pairs of straight strips 103½ ft. wide running at right angles to the mean slope, bounded above and below by 10 ft. grass strips. Wider service roads are provided where required, and diversion drains are planned after every four strips as a precaution against floods beyond the capacity of the normal conservation methods. The length of the strips is limited by the requirement that slope along the rows shall never exceed 2½%, and strips of the standard width will be confined to slopes not exceeding 6% across the strip. The basic soil and moisture conservation measure will be tie-ridging. While strip cultivation and tie-ridging will be practised over most of the farm, there will, of course, be numerous experiments for which different lay-outs are required, and in particular, experiments will be laid down to test the merits of the system. Lay-out will be influenced by the requirements of stock management such as size and shape of areas laid down to grass to economise fencing and water provision.

The crop husbandry research programme includes rotation problems, the establishment and utilisation of leys, the place of livestock in the farming system, and the utilisation of mechanisation. Rotation trials are complicated long-term experiments, and it is of the greatest importance to settle piecemeal as many of the problems involved in them as are amenable to separate treatment. The immediate programme consists, therefore, of small trials and observation experiments on crops and farming operations that may have a place in the rotation. Larger trials may be started in 1951.

Ley farming problems are largely concerned with the suitability of grasses for reliability in establishment (good seed production and ease of harvesting, rapid germination and quick cover), productivity and palatability to livestock, and good performance at the end of the ley period (ease of eradication and good after-effects on the subsequent crops). Studies of weed control are of importance in both the arable and ley phases.

Crop physiology studies will start from a consideration of the crop environment, and comprehensive meteorological data are being collected. These are arranged to provide data for a study of the relationships between the characteristics of tropical storms and the fate of rain, and will provide material for the development of a statistical estimate of "Effective Rainfall." As a base-line for fertility studies, soil samples have been collected and stored for future examination from 6 ft. pits dug at 50 yard intervals on a traverse across two of the main cropping areas of the farm. For the investigation of long-term effects of crop management on soil fertility and crop growth a continuous cultivation experiment has been laid out comparing tie-ridging and flat cultivation on slopes varying from 3% to nearly 9%. Two crops are included, cotton to represent annual crops and bananas to represent perennials. Methods of measuring water run-off and soil loss are under discussion.

In the cotton physiology programme, investigations on crop production will be closely associated with studies of lint development and quality. Plant development and crop production experiments have been initiated, one line of approach being the application of Ashby's conception of physiological age. The correlation of these with entomological and pathological studies will be used in assessing the importance of pests, diseases and climate in determining plant development in the Uganda crop. Later, investigations will be started on the effect of water and nutrient supply and leaf area on plant development and cropping capacity. Recent work has shown that little or no response to fertilisers is to be expected on rested land in Buganda, but further trials are being planned in collaboration with the Department of Agriculture. Physiological studies of plant nutrition will also lead to enquiries into the capacity of the soil to supply mineral nutrients.

Material collected in these crop development experiments will be available for study by the lint physiologist (expected about July, 1951). On the results obtained he will be able to plan a programme for the study of such problems of general importance to African cotton growers as the effect of climate on quality and the environmental factors affecting proneness to nep.

ENTOMOLOGY.

African cotton pests fall roughly into two groups, those which take the crop itself after the main plant structure has been established, and those which attack the vegetative parts of the plant before the main framework is established and reduce fruitfulness by destroying or distorting the structure. The first group includes bollworms and stainers, which are of most importance in the savannah regions of Africa with a single rainy season. Species of *Lygus* and *Helopeltis* fall into the second group, and are pre-eminently pests of cotton in the moist equatorial zone. Jassids, though belonging to the second group, are a limiting factor in the savannah areas.

Since Namulonge is situated in the moist equatorial zone, the second group, and *Lygus* in particular, must obviously have prior attention. The study of *Lygus* is complicated, however, by the effects of bacterial blight and climatic factors. *Lygus*, bacterial blight and the Uganda climate all tend to modify the structure of the cotton plant in the same way. Hence the first problem facing the entomological, plant pathological, and crop husbandry sections is the disentangling of the effects of *Lygus*, bacterial blight, and climate. Studies of the bionomics of *Lygus* will run concurrently with the assessment of its role in determining crop behaviour. The data provided by these investigations will provide an estimate of its present importance as a pest, its probable future behaviour under changing agricultural conditions, and the prospects of control either directly or by the development of resistant varieties.

Work on wider issues will be of two kinds, studies of widespread problems which will enable guiding principles of general application to be laid down, and basic entomological investigations that can best be tackled by a central organisation. In the immediate future, insecticidal work in co-operation with the Uganda Department of Agriculture, the East African Agriculture and Forestry Research Organisation, and the Colonial Insecticides Committee will take precedence over basic entomological work, and it is hoped that much time and trouble will be saved in other territories by the establishment of guiding principles in the use of insecticides on rain-fed peasant crops of tropical Africa.

Basic entomological work will be developed as staff and facilities permit. A problem of major importance in this field is that of the initiation, maintenance and termination of diapause in some of the bollworms. With pink bollworm the absence of diapause in Uganda and its relatively short duration in West Africa render this pest susceptible to control by close season measures in two otherwise extremely vulnerable territories, and knowledge of the physiology of diapause may well provide the key to control in other cases.

An important local problem for the entomological and pathological sections is the protection of experimental plots from disturbance by pest and disease attack.

Co-ordination of programmes in different territories is of particular importance for the success of the Corporation's entomological work. The Namulonge programme will have its applications in all African cotton-growing territories, British or non-British. On the other hand, it will be incomplete in itself, and will be complemented by entomological investigations carried on as far afield as Nigeria, Nyasaland, and eastern Tanganyika.

An important project connected with the co-ordination of entomological work is the preparation of a Handbook on Cotton Pests. Considerable progress has been made and it is hoped that the work will be completed as soon as the staff position becomes easier.

PLANT PATHOLOGY.

The important diseases of cotton in Africa are bacterial blight (*Xanthomonas malvacearum*), wilts (*Fusarium vasinfectum* and *Verticillium dahliae*), and virus diseases. Of these, virus diseases are serious only in *barbadense* cottons, which are virtually confined to West Africa and the Sudan. *Fusarium* occurs in parts of the Congo, but in Commonwealth territories *Verticillium* is the common cause of wilt. By far the most important disease is bacterial blight, and the greater part of the Plant Pathology programme will be concerned with it.

Genetic and plant breeding studies carried out in the Sudan, initially on resistant varieties obtained from botanists working in Uganda, have shown that bacterial blight can be controlled by the breeding of resistant varieties. Critical methods of assessing resistance have been worked out for the conditions of the arid northern Sudan, but are of little value in moist equatorial regions. Moreover, the impact of the disease is different in East Africa from that in the Sudan and though resistance identified in the Sudan has been shown to be of value in East Africa, the relative values of particular genes may well be different. The situation in Uganda is further complicated by the interaction of *Lygus*, bacterial blight and climate in modifying plant habit and cropping behaviour.

The bacterial blight problems to be investigated thus fall under the following heads :—

1. Methods of infection of leaves, stems and bolls ; factors influencing infection and the rate of tissue invasion ; means of spread ; factors influencing the extent of carry-over between seasons ; the possibility of control by seed disinfection.
2. The physiology of parasitism by *X. malvacearum* and the nature of resistance ; the development of sensitive tests of inherent resistance for use in plant breeding.
3. The assessment of the relative importance of bacterial blight and *Lygus* in Uganda.

Studies under the first two heads will be of general importance wherever rain-fed cotton is subject to bacterial blight attack. It will be necessary to supplement them with comparisons of the severity of the disease in different territories. These comparisons will be difficult to make, but they must be attempted first as an aid to better understanding of the epidemiology of the disease ; secondly, to investigate the possibility of strain differences in the bacterium ; and thirdly, to evaluate the importance of breeding resistant varieties.

Verticillium wilt has caused damage in parts of Uganda and highly susceptible varieties have suffered heavy losses in some plots at Namulonge. Considerable differences between varieties in wilt resistance have been demonstrated by botanists of the Uganda Department of Agriculture, and from the work of their pathologists it is clear that there is a balance between soil conditions and intensity

of disease attack. More information is needed on the present status of the disease, and its importance in the commercial crop. Further, the observation that the disease is worst in the most fertile fields gives real ground for the fear that steps towards increased production of cotton by improved cultural practices may be counterbalanced by increased severity of the disease, and possibly by outbreaks in areas not now affected. Three lines of work are necessary—studies on the influence of soil factors on the activity of the parasite and on carry-over in the soil; the influence of host physiology on susceptibility; and breeding for resistance.

PLANT BREEDING AND GENETICS.

The long-term cotton breeding objective is high cropping efficiency and suitable quality under East African conditions. In current commercial stocks in Uganda, a satisfactory crop is obtained in a rather cool climate and in the face of substantial disease and pest attacks by slow fruiting over a long period. Vegetative growth is vigorous, or even luxuriant, and the large plant that is produced will develop a fair crop in time, even though it suffers very considerable losses of fruiting points. Elimination of pest and disease attacks would result in an earlier crop, and in some advantage in yield, but the long and rather cool growing season and the impact of the pest and disease complex have led to the development of a type in which capacity to put on a heavy crop quickly has been sacrificed in favour of ability to produce a fair crop, even under very adverse circumstances.

The prospects of breeding really heavy cropping varieties under Uganda conditions depend on the elucidation of the complex interaction between pests, diseases and climate. Two important factors in this complex are bacterial blight and *Lygus*. Some resistance to bacterial blight is present in Uganda material, and work in the Sudan has established the practicability of breeding Upland cottons virtually immune to the disease. High resistance to *Lygus* is at present unknown but a measure of resistance has been reported on several occasions in widely different breeding stocks. There are, therefore, grounds for believing that, by the concentration of genes from many sources, it should be possible to achieve a degree of resistance of some practical value.

The first stage of the long range breeding problem may then be defined as the transference of really high bacterial blight resistance to all the more important East African stocks. For Uganda the development of *Lygus* resistance is next in importance, and breeding work will be carried on to the provision of nucleus stocks for multiplication. For other territories the work of the Cotton Research Station will be limited to the synthesis of resistant stocks with sufficient variability to respond to local selection.

Given sufficient genetic resistance or insecticidal control to reduce the importance of pests and diseases, the way will be open for the synthesis of varieties with a high cropping efficiency, and the

second stage of the long range programme will be the breeding of lines giving a high ratio of seed cotton to vegetative parts in the pest and disease resistant stocks. Information on fruiting habit and response to environment is much less adequate than that on disease and pest resistance, and progress in this part of the programme will depend on the results of physiological studies of the reaction of cotton varieties to climatic factors. Nevertheless, observations on a wide range of Upland types have indicated a few groups of superior cropping capacity under the low maximum temperature and low light intensity conditions of Buganda, and these are available as parent material.

Breeding lines are in course of development which will increase the range of material available for study. A wide range of stocks from the Barberton Station will be under observation in the current season. A line started at Shambat in the Sudan aims at the establishment of good staple in the MU.8 variety, which has proved to be a high yielder under a wide range of conditions. A disease resistance line was started last season by crossing a high bacterial blight resistance stock out of Nigerian Allen with BP.52. In the current season the F_1 will be backcrossed to all the more important East African commercial varieties. Using another method of approach based on the modern theory of population genetics, a mixture of strains of widely different origin has been made up, having among them all the more important characters it is desired to combine, and will be bred under conditions of panmixis (random intercrossing).

From these experiments practical results will only be obtainable after some years of work, and, moreover, the direction and scope of this type of breeding will change as information becomes available from crop husbandry experience and entomological and plant pathological studies. Meanwhile breeding work with a more immediate application is in progress for the improvement of commercial Uganda stocks.

By arrangement with the Uganda Department of Agriculture, a Corporation plant breeder took over the pedigree BP.52 breeding stocks in 1946, and breeding and selection work has since been carried on in replicated trials. Seed is multiplied by the Department and pedigree seed of improved lines has been handed over for testing and multiplication in the current season. Work on the S.47 type of cotton for areas east and north of the Nile is now being undertaken. It is the experience of botanists in the Department of Agriculture that cotton breeding for the Eastern Province can be conducted successfully in the zone in which Namulonge is situated, and it is therefore proposed to centralise the S.47 (ex BP.50) as well as the BP.52 work at Namulonge at present. The division of Namulonge into three comparatively isolated blocks makes it possible to conduct the two breeding programmes without risk of intercrossing.

The replicated progeny row system of breeding differs in important respects from other systems that are in common use. It has the

advantage of yielding data on which the rate of progress and the prospects of further advance can be estimated, and the possibility of considerable further improvement in BP.52 has already been demonstrated. With a range of breeding projects, other breeding methods will be in use, and comparisons of their efficiency will be made which are likely to be of general interest.

[Included by courtesy of the Uganda Government.]

UGANDA.

REPORT OF THE SENIOR BOTANIST, 1949-50

BY

J. D. JAMESON.

BLACKARM DISEASE OF COTTON.

Blackarm is the premier disease of cotton in Uganda, and is responsible for a considerable loss of crop almost every year. Experimental work on the disease has been in progress for 23 years, and in the season under review an attempt was made to bring all accumulated experience together in an intensified effort to devise practical means of control.

History.

The identity of the disease variously known as angular leaf spot, blackarm and bacterial boll rot, according to its location on the plant, was established in this country by Snowden (¹) in 1926 as *Bacterium malvacearum* E.F.S., since re-named *Xanthomonas malvacearum* (E.F.S.) Dowson. The name bacterial blight has been applied to all manifestations of the disease, but it is still most generally known in Uganda as blackarm.

In his original paper, Snowden recognised most, if not all, of the likely means of control, namely :

- (a) chemical disinfection of the seed
- (b) drying the seed
- (c) heating the seed above 50°C.
- (d) exposure of the seed to sunlight
- (e) prolonged storage of the seed
- (f) breeding resistant varieties.

The serious blackarm epidemic of 1929 greatly stimulated research. Hansford(²) studied the spread of the disease in the field, and surveyed in detail the relation between yield and various measurements of blackarm damage. Of the likely control measures (a) and (f) were studied first. Important results were obtained by chemical disinfection of seed, but as all the active substances were dangerous mercury compounds, unsuited to the primitive conditions then prevailing, this work was suspended after 1934 in favour of breeding resistant varieties.

The early history of the resistant foundation stocks is now of considerable interest. Apart from Snowden's original observation on resistance, the following early selections attained the most importance :

B 31 : selected by Nye at Kabasanda in 1929, and used by Knight(³) as the starting point of his work in the Sudan.

B 37 : selected by Stephens in Bulemezi in 1929, and the ultimate parent of BP 50 and S 47.

SG 129 : selected by Nye and Hosking at Nariama in 1929.

U 4 : introduced to Serere from Barberton in 1929.

B 181 : selected by Nye in Buganda in 1933, and subsequently used as donor parent for the transference of resistance to BP 52.

Unfortunately the lesion count originally adopted by Hansford was not independent of plant size, so that large plants tended to have a greater number of lesions and a larger yield than small plants. Clearly a measurement that was not inversely related to yield could not be regarded as a satisfactory estimate of damage or as a satisfactory criterion of resistance, though it might have value as an estimate of seasonal incidence.

This difficulty was met from 1935 onwards by recording the presence or absence of infection on the main stem, an observation which is independent of plant size. This observation also failed for a time, because it was taken late in the season, and was intended to be a summation of the season's damage. It failed because secondary infection between adjacent material tended to level up the attack. It was not until 1944 that we settled upon a fairly good measure of damage, inversely related to yield, by taking the main-stem observation within two months from planting. Even then the material had to be of like origin ; that is from seed with comparable amounts of primary infection, or from seed which was artificially standardised.

Attention was diverted from the lesion count however by the publication in 1939 of Knight's work (*loc. cit.*) on the major genes for resistance and the technique of leaf spot grading in the Sudan. This technique worked well enough under certain conditions at Serere, and led to the breeding of the resistant variety S.47 in 1942-44 from a heterozygous stock of BP.50 preserved from the original 1935 bulk seed. This result more than justified the use of Knight's technique. But the method was not successful at Kawanda, and even at Serere its behaviour was much modified under heavy rainfall as opposed to the arid climate of Khartoum. This aspect of the method is discussed by Jameson⁽⁴⁾, and it is now generally agreed that the gene B₂ alone confers very limited resistance on cotton growing under rainfall.

These considerations led to a fresh review of main-stem infection, as already described. The discovery that main-stem infection in the first two months of the life of the plant could be critical for yield immediately suggested that a fresh attempt should be made to avoid primary infection by cleaning up the seed before planting. Our intention to re-open the question of seed disinfection was made public, and was met by an immediate offer of collaboration from Messrs. Imperial Chemical Industries Ltd. This collaboration was accepted, and the work started in 1949, with the avowed purpose of discovering

an effective chemical seed dressing which would not be dangerous to humans in a relatively primitive community.

Programme for Blackarm Control.

Dr. G. Watts Padwick visited East Africa from December, 1948, to March, 1949. Besides arranging the collaboration, he made a major contribution by suggesting in correspondence that we check Hansford's⁽⁵⁾ conclusion that bacteria on the seed coat constitute the principal source of primary infection, and that rainfall in Uganda normally disposes of all infected trash left in the field during the close season. This suggestion gained force from the very dry weather experienced at Serere during the close season of 1949. A re-examination of past records from this point of view revealed strong evidence that the early onset of rain in the close season is one critical factor for deciding the amount of blackarm in the subsequent crop, and the eventual yield of that crop. This finding provided the final link in the chain of reasoning built up since 1942 by Jameson⁽⁶⁾ about the cotton crop in relation to climate and disease. The first questions to be settled therefore were whether the carry-over of blackarm in trash could be demonstrated as a fact, and if so whether seed dressing would afford a measure of protection against this form of primary attack also.

Mr. D. G. Thomas, botanist, was posted to Serere in April, 1949, to devote his whole time to blackarm control. Messrs. Plant Protection Ltd., a subsidiary of I.C.I. Ltd., made available Mr. W. T. Cowan to collaborate with him for two periods during the season. In September, 1949, Mr. J. G. Wilson, Agricultural Assistant, was posted to assist Mr. Thomas.

1949-50 Season.

Experimental work at Serere yielded a large amount of very interesting information. But the first results from a new programme inevitably relate to one season only, and all the more debatable conclusions lack confirmation. At the time of writing the work of the second season is well advanced, and it has been decided therefore to defer the first progress report until the results from two seasons are available.

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ANGLO-EGYPTIAN SUDAN.

PROGRESS REPORT OF THE PLANT BREEDING STATIONS, SEASON 1949-1950.

PLANTING AND PICKING DATES.

Area.	Average Planting Dates.	Average Picking Dates.	Close Season.
Gezira	10th Aug.-15th Sept.	30th Dec.-1st April	15th April-10th Aug.
Gash Delta	20th Aug.-20th Sept.	10th Jan.-30th April	30th April-20th Aug.
Tokar	7th Sept.-15th Oct.	1st Jan.-31st May	1st June-20th Aug.
Kordofan	15th June-15th Aug.	15th Oct.-1st March	31st March-15th June
Zeidab	1st May-15th May	1st Sept.-30th Sept.	1st Jan.-30th April
Equatoria	15th May-31st Aug.	1st Oct.-15th Feb.	31st March-15th May

INTRODUCTORY NOTE.

BY

R. R. ANSON.

The total area under cotton in the Sudan amounted to 414,364 acres and the estimated yield from this area was 417,924,360 lb. of seed cotton. This acreage was made up of 318,916 acres of Egyptian varieties, mostly irrigated, and 95,448 acres of American long stapled varieties; 6,768 acres of the American varieties were irrigated and 88,680 acres were rain grown.

Growing conditions throughout the Sudan varied considerably from one locality to another.

Gezira (Domains Sakel "S" cotton, and X.1730A "L" cotton).

The estimated yield was 1,390 lb. of seed cotton per acre. However, conditions were favourable throughout and the crop is expected to exceed this estimate.

In contrast to last season, grade was good and bolls opened normally. Blackarm infection was slight and leafcurl negligible. Whitefly (*Bemisia* spp.) did not appear until late in the season. This to some extent accounted for the absence of "asal"* and leafcurl and enabled the crop to continue to final maturity unchecked.

The total area was 207,556 acres, made up as follows :—

1. Sudan Plantations Syndicate and Kassala Cotton Company, 111,388 acres of Domains Sakel and 95,349 acres of X.1730A.
2. Gondal, 644 acres of blackarm resistant Sakel.
3. Research Division, 175 acres of mixed Domains Sakel and X.1730A.

White Nile Schemes. (All X.1730A).

The total area was 36,260 acres, and the estimated yield 1,260 lb. seed cotton per acre. The cotton was generally healthy throughout and the crop will exceed the estimate. Grade was satisfactory except at Wad Nimr.

* Asal : A sticky honey-like secretion found on cotton leaves and sometimes accentuated by aphid or whitefly.

Tokar.—The effective area was 30,265 acres. Except for a $4\frac{1}{2}$ acre experimental strip of leafcurl resistant Sakel, the whole area was sown with X.1730A. The final estimate, 330.5 lb. seed cotton per acre, is low because of failure of autumn rains and complete drought throughout the winter months.

This year the Tokar market opened for the first time since the beginning of the war and several new firms participated in buying. The quality of the cotton for sale during the first week was reported to be below average but later in the season the quality improved and good prices were realized.

Gash.—The total effective area was 44,840 acres, made up as below. The estimated yield was 30,781,845 lb. of seed cotton, or 686 lb. per acre.

(1)	Domains Sakel	...	...	...	16,038 acres	
	Dom. Sakel Evelyns	...	...	...	2,167 "	
	Total area of Dom. Sakel	...	...	...	18,205 acres	18,205 acres
(2)	X.1730A	...	...	...	25,360 acres	
	BAR.XL-1	...	...	...	886 "	
	BAR.4/16	...	...	...	188 "	
	BAR.14/7	...	...	...	201 "	
	Total	...	...	...	26,635 acres	26,635 acres
						44,840 acres

Short watering, owing to poor Gash flow, caused early drying out of some of the second rotation. Towards the end of the season bollworm damage was severe. Sudan bollworm (*Diparopsis castanea*), Egyptian bollworm (*Earias insulana*) and Pink bollworm (*Platyedra gossypiella*) were all troublesome.

American Irrigated (Variety Coker Wilds $1\frac{15}{16}$ " staple).

The total area planted was 6,768 acres, comprising 5,284 acres at Zeidab, the former Sudan Plantations Syndicate Estate, and 1,484 acres from other private Estates. The average yields per acre from these two areas were 1,189 lb. and 403 lb. seed cotton per acre respectively.

Kordofan (Nuba Mountains).

The variety grown, BAR.SP.84 is a blackarm resistant selection from Uganda SP.84. The estimated area under this variety was 76,030 acres; this is slightly more than last season but the average yield of seed cotton per acre, 264 lb., is less than that of last season (307 lb. per acre).

This poor yield is attributed to (a) scanty and badly distributed rains experienced in most areas situated North of 12th parallel; (b) late planting (some peasants did not plant until the first week in September, this being the date that prices to be paid for the seed cotton were announced); (c) to the fact that, as a cash crop, dura (*Sorghum vulgare*) is becoming a serious competitor of cotton. During the season large quantities of grain were exported from the Kadugli and Talodi districts.

Equatoria (Variety BAR.SP.84).

12,650 acres were planted and a final yield of 4,762,485 lb. of seed cotton was obtained. This average yield of 376 lb. of seed cotton per acre is a slight increase over last season. Rains, however, were irregular and boll shedding widespread so that ultimately the crop was disappointing.

THE GEZIRA STATION

BY

R. R. ANSON AND K. C. BARLOW.

METEOROLOGY.

Rains commenced in May with frequent light showers. There was very little rain in June and the first reasonable precipitation did not take place until 20th July. The wet season closed down after mid-October.

Average monthly readings were :—

				Average Maximum Temperature.	Average Minimum Temperature.	Average Relative Humidity 8 a.m.	Total Rainfall mm.
April	1949	...	...	104.9°F.	68.0°F.	12	—
May	"	...	...	105.1	75.0	41	50.0
June	"	...	...	103.5	75.2	47	36.7
July	"	...	...	99.9	75.0	59	48.1
August	"	...	...	96.4	71.8	73	47.4
September	"	...	...	96.8	70.7	71	57.2
October	"	...	...	101.5	71.1	54	8.0
November	"	...	...	98.1	63.9	33	—
December	"	...	...	88.7	53.2	33	—
January 1950	...	...	...	93.7	57.0	37	—
February	"	...	...	95.0	58.1	30	—
March	"	...	...	101.3	65.1	18	—

BREEDING AND VARIETY TESTING.

The breeding plot was sown on 15th August. Germination was slow and irregular. This was most noticeable in Sakel types, and, in instances where seed rate had to be low owing to small supplies, complete failure resulted. Weed growth was strong and heavy rain at the end of August delayed resowing. Later in the season termite damage was considerable and, as a control measure, poisoned sawdust was applied by hand. Blackarm, thought to be primary infection, was first discovered on Sakel progenies on 25th September. The following material was planted and analysed.

Strain.	Blackarm resistance genes.	No. of progenies.	No. of bulks.	Characters under selection.
<i>Sakel types.</i>				
BAR. 14/1	B ₁	12	—	Lint index and G.O.T.
"		5	4	Low node number.
BLR. 14/16	B ₁	500	—	
		random		
		plants		
Domains Sakel (Early)	—	6	—	Low node number.
<i>X.1730 types.</i>				
BAR. XL. and XLI.	B ₁	39	—	Good boll opening and good lint.
BAR. XL2	B ₁	28	—	Later discarded.
BAR. 4/5	B ₁	25	—	Good boll opening and G.O.T.
BAR. 4/11	B ₁ B ₂	25	—	Yield and quality.
BAR. 14/16	B ₁ B ₂	44	—	
JR. 1530	—	—	6	

BOLL DEVELOPMENT MATERIAL.

Boll development material has been collected and forwarded to the Shirley Institute for analysis.

GRADE EXPERIMENTS.

Cotton Observation Plot. Dated flowers of 100 plants from 5 varieties.

It has been postulated that under normal conditions in the Gezira, the best grade comes from the first flush of open bolls and is gathered with the first pickings.

These bolls usually come from the lower portion of the plant, they are the first to receive full nourishment and develop under more humid conditions than bolls higher up the plant.

To obtain more information on this subject it was decided to tag flowers on five consecutive days at fortnightly intervals. The Chief Classifier of the Sudan Plantations Syndicate very kindly consented to grade the samples.

Results given in the following table are in accordance with expectations.

<i>Date of flowering.</i>	<i>No. of flowers.</i>	<i>Date of Picking.</i>	<i>No. of Bolls Picked.</i>	<i>Loss %.</i>	<i>Grade.</i>
5/11-9/11/49	213	<i>Bar. 14/7.</i>			
21/11-25/11/49	90	7/1-22/1/50	142	33.3	X.1
5/12-9/12/49	12	31/1-5/2/50	35	61.1	1
19/12-23/12/49	4	2/2-22/2/50	10	16.6	X.2
		None	None	100.0	—
5/11-9/11/49	201	<i>Domains Sakel.</i>			
21/11-25/11/49	84	7/1-22/1/50	122	39.3	1
5/12-9/12/49	4	21/1-9/2/50	22	73.7	X.2
19/12-23/12/49	None	None	None	100.0	—
		None	None	None	—
5/11-9/11/49	173	<i>X.1730 A.</i>			
21/11-25/11/49	158	7/1-9/2/50	110	36.4	X.1
5/12-9/12/49	34	31/1-18/2/50	79	50.0	2
19/12-23/12/49	6	9/2-18/2/50	13	61.7	3
		16/2-22/2/50	3	50.0	2
5/11-9/11/49	147	<i>Bar.X.1730L-1.</i>			
21/11-25/11/49	170	8/1-5/2/50	90	38.7	1
5/12-9/12/49	31	31/1-18/2/50	37	78.2	2
19/12-23/12/49	None	2/2-18/2/50	12	61.3	3
		None	None	None	—
5/11-9/11/49	272	<i>BLR. 14/16.</i>			
21/11-25/11/49	165	7/1-6/2/50	117	57.0	1
5/12-9/12/49	23	23/1-9/2/50	41	75.0	2
19/12-23/12/49	None	6/2-16/2/50	6	74.0	2
		None	None	None	—

Sowing Date Trials (carried out by the Sudan Plantations Syndicate).

Early sowing with slightly wider spacing has been suggested as a probable means of grade improvement. However, for obvious reasons, early sowing of blackarm susceptible material would have been unwise and improvident. When blackarm resistant material became available, an experiment designed to give some information on the advisability of early sowing was set out in the 1947/48 season at Fahl. Unfortunately the seed bed was bad, seed did not germinate well, and that which did germinate was subject to severe flea-beetle attack; added to this, resowings were delayed because they coincided

with the Feast of Ramadan and labour was unobtainable. In spite of all these catastrophes, the early sown material bulked in a slightly better grade than did the control areas sown at normal time.

The following year, 1948/49, 500 acres each were sown *early* to BAR.4/5 and BAR.X.1730L; these two areas were for comparison with X.1730A of *normal* sowing date planted on comparable areas. The season was bad for grade, one of the worst in this respect for many years, and this must have masked the advantages of early sowing to some extent. However, the average grade from the early sown material was again slightly better than that from the normal sowing date. This season, 1949/50, the Sudan Plantations Syndicate again carried out another trial. This time the trial was situated on Kumor Block and treatments were as follows:—

- (1) (1) 70 acres BAR.X1730L sown early, wide spacing 50 cms.
- (2) 70 " " normal date, normal spacing (35–40 cms.).
- (3) 70 " X.1730A control sown normal date, normal spacing (35–40 cms.).
- (2) (1) 70 acres BAR.X.1730L–1 sown early, wide spacing 50 cms.
- (2) 70 " " normal date, normal spacing (35–40 cms.).
- (3) 70 " X.1730A control sown normal date, normal spacing (35–40 cms.).

The following table has been compiled from results supplied by the Inspector, Kumor Taftesh. This shows that at normal sowing date over 40% of the crop was Grade 5, whereas areas sown 3 weeks earlier gave 40% of their crop in Grade 1.

THE SUDAN PLANTATIONS SYNDICATE LIMITED—KUMOR TAFTESH No. 6.
COMPARISON OF YIELD AND GRADE OF EARLY SOWN AND NORMAL BAR.XL AND BAR.XL1 WITH XA. (CONTROL).

Variety.	Sowing Date.	Spacing.	Yield in lb. S/C per acre.	Percentage Seed Cotton in Grades.						Mean Grade.
				1	2	3	4	5	6	
XA. Control ...	Aug. 18–22	Normal	1833	8	9	19	3	47	14	4.1
BAR.XL. ...	Aug. 18–22	Normal	1472	6	9	22	4	42	17	4.1
BAR.XL. ...	July 29–Aug. 2	Wide	1406	48	14	20	5	12	1	2.2
XA. Control ...	Aug. 18–23	Normal	1469	11	10	16	12	38	13	3.9
BAR.XL1 ...	Aug. 18–26	Normal	1439	1	6	10	12	45	26	4.7
BAR.XL1 ...	July 29–Aug. 1	Wide	1629	39	16	22	7	12	4	2.5

LEAFCURL RESISTANCE.

Plots earmarked for leafcurl resistant material were sown on 15th September, one month later than the main Breeding Plot. The object of this was to promote conditions favouring the spread of the disease.

The general design of the experiment was modified slightly in that, instead of alternating individual plants with spreader material, resistant rows were alternated with susceptible rows. Germination was good and growth has been satisfactory. Throughout the first part of the season there was a complete absence of whitefly (*Bemisia* spp.) and leafcurl. The first trace of leafcurl appeared on 1st April, 1950, when 13 plants in the spreader belt on the Western side of the experiment were found to be slightly infected. Counts made fourteen days later revealed 81 plants (all spreaders) infected. The cotton bushes

were cut back on 18th April, 1950, and left to ratoon. Final counts, made on 25th May, 1950, in which the susceptible material averaged 97.7% infection, are shown below.

Table showing the percentage of infected plants in resistant material after cutting back.

Treatment.	Blocks.						Total.	Average.		
	1		2		3					
Control RDS 1/48	91.7	4.2	100	24	96	16	287.7	44.2	95.9	14.7
Control RDS 2/48	100	0	100	32	100	8	300	40.0	100	13.3
Control RDS 3/48	96	4.2	100	16	100	36	296	56.2	98.7	18.7
Control RDS 4/48	95.8	8	100	8	100	8	295.8	24.0	98.6	8.0
Control RDS 6/48	100	5	100	9.1	100	8	300	22.1	100	7.4
Control BLR 14/16	92	0	100	12	100	24	292	36.0	97.3	12.0
Control BLR 14/1	96	4	96	12.5	95.8	12	287.8	28.5	95.9	9.2
Control BAR.X1730L	91.7	8	95.8	40	100	52	287.5	100.0	95.8	33.3
Control BAR. 4/5	100	12	100	16	100	4	300	32.0	100	10.7
Control BAR. 4/11	96	20	96	56	100	52	292	128.0	97.3	42.7
Control BAR. 4/16	87.5	20	100	40	100	16.7	287.5	76.7	95.8	25.6
Control X.1730A	100	12	100	37.5	92	48	292	97.5	97.3	32.5
Blocks Total	1146.7	97.4	1187.8	303.1	1083.8	284.7	3418.3	685.2	—	

RDS. 6/48	RDS. 4/48	BAR. 14/1	BAR. 4/5	BLR. 14/16	RDS. 2/48	RDS. 1/48	RDS. 3/48	BAR. 4/16	X1730A	BAR. X1730L	BAR. 4/11
7.4	8.0	9.5	10.7	12.0	13.3	14.7	18.7	25.6	32.5	33.3	42.7

Treatments within the same bracket do not differ significantly.

KEY TO VARIETIES TESTED.

RDS.
BLR. 14/16
BAR. 14/1
BAR. 1730L.
BAR. 4/5.
BAR. 4/11
BAR. 4/16
X. 1730A.

Leafcurl resistant Domains Sakel.
Blackarm resistant Sakel selected for leafcurl resistance.
Blackarm resistant 1730 (B₂) selected for leafcurl resistance.
Blackarm resistant 1730 (B₂ B₃) selected for leafcurl resistance.
Main crop 1730A.

Leafcurl resistant Sakel obtained from bulkings (selfed material) of R.D.S. Selections 1, 2, 3 and 4 in season 1948/49 were grown on a $4\frac{1}{2}$ acre observation plot at Tokar. No trace of leafcurl was found on this cotton. It averaged 425 lb. of seed cotton per acre and was considerably better than the adjacent X.1730A. Further trials on a larger scale will be made at Tokar next season.

OBSERVATION PLOTS.

On the recommendation of the Cotton Varieties Sub-Committee, a number of Egyptian varieties were grown in Observation Plots. This was done in order to study their behaviour under Gezira conditions and, at the same time, to ascertain whether an inherent variability for good and bad boll opening exists between one variety and another. These new importations comprised *Karnak*, *Giza 7*, *Giza 30* and *Menoufi*.

The season was a particularly good one for grade and there were not many cases of bad boll opening. There was no marked difference in this phenomenon between varieties. *Giza 30* and *Menoufi* seemed slightly better than the others: *Karnak* lodged badly and was most susceptible to thrips attack.

VARIETY TRIALS.

Six Sakel types and nine X.1730 types were included in the variety trials. DS.2 and DS.S (mixed), included last year, were dropped, and BLR.14/16, BAR.NT 2/41, and BAR.4/11 were added. The trials were sited at Gezira Research Farm (Centre), Hag Abdulla (South) and Turabi (North), as in previous years.

At the G.R.F. a period of hot dry weather experienced shortly after germination retarded growth for a short time, but plants recovered with the first rain. Towards the middle of September blackarm infection, thought to be primary, was noticed on J.R.1530. This subsequently spread to all susceptible varieties, which showed severe symptoms throughout the early growing period.

Conditions at Hag Abdulla were very similar to those at G.R.F. Plants suffered an early setback but afterwards recovered. Throughout the season, blackarm was severe on all susceptible varieties.

At Turabi germination was good. Blackarm was present but not severe. In September heavy dust storms checked plant growth on the northern end of the experiment.

GEZIRA VARIETY TRIALS 49/50.

	BAR Genes.	G.R.F.			Hag Abdulla.			Turabi.		
		Seed cotton lb. per acre.	Lint lb. per acre.	G.O.T.	Seed cotton lb. per acre.	Lint lb. per acre.	G.O.T.	Seed cotton lb. per acre.	Lint lb. per acre.	G.O.T.
<i>Sakel Group.</i>										
D.S.1 ...	—	1,149	382	33.3	696	221	31.8	1,478	489	33.1
D.S. Control ...	—	1,097	353	32.2	619	191	30.9	1,465	467	31.9
R.D.S. ...	—	1,331	465	35.0	619	203	32.9	1,333	473	35.3
BAR.14/7 ...	B ₂	1,394	407	29.2	1,057	299	28.3	1,230	365	29.7
BLR.14/16 ...	B ₂	1,342	387	28.9	—	—	—	—	—	—
BAR.N.T.2/41 ...	B ₂	—	—	—	1,574	466	29.6	1,199	368	30.7
<i>X.1730 Group.</i>										
X.A.G. ...	—	1,323	467	35.3	994	334	33.6	1,414	492	34.8
X.A.T. ...	—	1,354	484	35.8	894	308	34.5	1,330	458	34.5
BAR.X.L. ...	B ₂	1,393	516	37.1	1,265	434	34.3	1,355	479	35.4
BAR.X.L-1 ...	B ₂	1,491	526	35.3	1,304	434	33.3	1,327	462	34.8
BAR.X.L-2 ...	B ₂	1,429	505	35.4	1,298	432	33.3	1,255	429	34.2
BAR.4/5 ...	B ₂	1,445	484	33.5	1,341	423	31.6	1,149	370	32.2
BAR.4/11 ...	B ₂ B ₃	1,376	455	33.1	1,341	419	31.3	1,197	389	32.5
BAR.4/16 ...	B ₂ B ₃	1,400	464	33.2	1,337	420	31.4	1,053	347	33.0
J.R. 1530 ...	—	1,032	401	38.9	660	253	38.3	1,369	520	38.0

At the 5% level the significant differences for seed cotton were 172.4, 150.0 and 136.1 lb. per acre at Hag Abdulla and Turabi respectively.

PESTS AND DISEASES.

Jassid (*Empoasca lybica*).—The jassid attack reached its peak towards the middle of November and caused considerable damage. The whole of the Breeding Plot was sprayed with DDT, an effective control.

Whitefly (*Bemisia* spp.).—This did not appear in any numbers until late in the season, when it did little damage.

Termites.—These were troublesome in early September and were controlled by the application of poisoned sawdust.

Bollworm.—Bollworm attack was never severe.

Thrips (*Thysanoptera*).—This pest appeared in late December. Karnak and other recent importations from Egypt were more susceptible to thrips than local varieties, but yield was not seriously affected.

Flea beetle (*Podagrica* spp.).—Some damage was done in September.

Blackarm (*X. malvacearum*).—The disease was first noticed in September and spread to all susceptible varieties. The attack was severe and caused considerable damage at the G.R.F. and Hag Abdulla variety trials.

Leafcurl.—This did not make an appearance in bulk plantings; it was in evidence only in late planted spreader material and in a few susceptible Sakel strains in the Breeding Plot.

SUMMARY AND CONCLUSIONS.

1. Under Gezira conditions the seed cotton picked from the lower sympodia of healthy plants produced the best grade.

2. Early sowing with slightly wider spacing of blackarm resistant strains produced better average grade than normally spaced cotton planted at the normal time.

3. Some strains of Sakel and X.1730, highly leafcurl resistant, have been selected and will be bulked next season.

4. Domains Sakel and Evelyn's Sakel did not differ significantly in yield of seed cotton per acre.

5. Some blackarm resistant strains of Sakel and X.1730 in the presence of severe blackarm attack gave significantly better yields of lint per acre than susceptible strains.

6. Figures from the three variety trials sited within the Gezira area indicate that in terms of seed cotton per acre, Gash grown seed has no advantage over that produced in Tokar.

SHAMBAT STATION

BY

R. L. KNIGHT AND J. E. SADD.

STAFF.

Mr. Sadd joined the Section on 16th September, 1949, as Economic Geneticist. He is stationed at Shambat.

METEOROLOGY.

Rains started in May and finished in October, but the total rainfall for the year was only 1.6 inches—less even than last season and only about a third of the normal. Temperatures throughout the season were rather high, and during the period 1st May, 1949, to 30th April, 1950, there were 212 days when the shade temperature registered 100°F. or over, 40 days with 110°F. or more, and one day with a temperature of over 115°F. These figures compare with 204, 33 and 2 days respectively, representing the average for the previous seven seasons.

GENETICS AND BREEDING.

Production of blackarm resistant "Egyptian" varieties.

Blackarm resistant Domains Sakel.—In last season's report (p. 62) the genesis of the blackarm and leafcurl resistant BLR.14/16 was given. One feddan of BLR.14/16 was sown with bulked seed of 242 leafcurl free plants on 30th October, 1948. This was cut back on 4th May, 1949, at the end of crop, and, when secondary growth had started, was regularly rogued for leafcurl. 694 leafcurl plants were removed during the summer. A further 1,851 plants were pulled up as being possibly lacking in vigour and the 2,032 plants which remained were then treated as an isolated propagation plot. Seed from these was used to sow a five feddan propagation area from which will come a second wave of BLR.14/16 presumably even more resistant to leafcurl than was the original material.

The production of a strain of Sakel carrying both B₂ and B₃ was completed this season and 1/3rd feddan was sown with this new type on 11th January, 1950, under the reference number BAR.14/21. It is intended to make this resistant to leafcurl next season by the same process as was used in creating BLR.14/16 from its parent type BAR.14/7.

The transference of the *arboreum* gene B₄ to Evelyn's Selected Sakel was completed this season and a small propagation plot of 10th *barbadense* backcross (6th backcross to Evelyn's Sakel) material, homozygous for B₄, was grown under the reference number BAR.14/19.

In a second transference from tetraploid *sanguineum* (*G. arboreum* race *bengalense*, Silow) to Sakel, a number of third backcross families were successfully grown and selected plants in these were further backcrossed to Sakel. Susceptible plants in these progenies were

crossed with BLR.14/16 so as to pick out the main blackarm resistance intensifying gene, if present. The major objectives in making this second transference from *arboresum* were given in last season's report (p. 63).

In the hybridization between tetraploid *herbaceum* (Wagad 8) and Sakel, the *herbaceum* gene for blackarm resistance was successfully taken to the third backcross, and fourth backcross seed was obtained for sowing next season. The relationship between this *herbaceum* gene and the *arboresum* B₄ is not yet known.

B₅, the gene from the perennial *barbadense* type Grenadines White Pollen, was successfully carried to the fourth Sakel backcross, and fifth backcross seed was obtained for sowing next season.

Blackarm resistant X.1730.—Details of existing strains will be found in the Report for the Gezira Station (Medani). No further work is being done at Shambat on blackarm resistant X.1730 types because sufficient variability appears to exist in BAR.4/16 (B₂ B₃ 1730) to make it suitable for selection work by the Cotton Breeders at Medani.

Production of blackarm resistant strains of American Upland and the examination of imported Upland types.

A crossing programme was started this season to incorporate B₃ into BAR.NT.96/40—a type from Kadugli homozygous for B₂. As a start BAR.7/8 (a B₂ B₃ strain of Uganda SP.84) was crossed with BAR.NT.96/40 on a wide basis and the F₁ of this cross will be sown next season and used for backcrossing to BAR.NT.96/40.

C (48) 4, a BP.52 stock from Namulonge, was examined for blackarm resistance in 1949-50 winter. It contained 213 resistant plants and 69 susceptible; there were, in addition, 4 plants whose classification was doubtful. The resistant plants were individually selfed and these will be sown in progeny rows next season, in order to get a "bulk" homozygous for B₂. The transference of B₃ to these resistant plants was begun but, over and above this, an attempt will be made to increase the resistance of the B₂ component by spraying with blackarm each season and selecting for maximum resistance, thus building up a gene complex fortifying B₂.

The gene controlling the blackarm resistance of Stoneville 20 has been transferred by three backcrosses to a sufficiently uniform Sakel background for its value to be determined next season. In addition, individual F₁s of Stoneville 20 carrying B₁, B₂, B₃, B₄ and B₅ respectively were grown, so that gene homology tests can be carried out next season on F₂ material.

The blackarm resistance of *G. anomalum* is recessive. Material selfed out from second backcrosses to susceptible *G. arboresum* (Java) was grown this season and the resistant plants in this were again crossed with Java. It is intended, next season, to make crosses with an *arboresum* carrying B₄ so that the relationship between blackarm resistance in *G. arboresum* and in its wild relative *G. anomalum* can be investigated.

Jassid resistance.

The economic and genetic background of this line of research was given in the 1947-8 Report (p. 60) and in a forthcoming paper in the *Journal of Genetics* (Knight).

This season the full MU8b hairiness was recovered in F_2 s of the third Sakel backcrosses. The resistance of MU8b has been shown to depend on a basic hairiness gene H_1 , fortified by modifying genes and by minor genes having of themselves a direct action on the production of hairs.

In the transferences from Ferguson, the full parental hairiness was recovered in the third backcross F_2 s, but many of the families still carried a high degree of sterility. The hairiness mechanism of Ferguson is also based on a key H gene (whose relationship with the other known genes H_1 , H_2 and H_3 has not yet been determined), accompanied by length intensifiers. The number of length intensifiers involved appears, fortunately, to be small.

This season, jassids were general and severe and the immunity of these types selfed out from Sakel backcrosses involving MU8b and Ferguson was outstanding.

The basic gene controlling hairiness in Kapas Purao is H_3 and this is closely linked with one of a pair of duplicate genes for chlorosis. In Kapas Purao this gene is harmless, but transferring H_3 to Sakel has, so far, given chlorotics* as a final product. This gene has now been carried to the 7th Sakel backcross, and 8th backcross material will be sown next season and selfed to see whether this linkage has been broken.

The hairiness gene from Pubescent T.611 has been transferred as far as the 3rd Sakel backcross and 4th backcross seed is available for sowing next season. This gene is the strongest H gene so far studied.

In crosses involving *G. tomentosum*, the hair density gene H_2 was taken to the 5th Sakel backcross. It is of interest that at this stage it was still associated with a shortening of the leaf lobes, as noted by Harland.

In transferring hairiness from *G. arboreum* and *G. herbaceum* the basic H genes were successfully carried to the third Sakel backcross and fourth backcross seed has been obtained for sowing next season.

Other crosses involving *G. mustelinum*, *G. punctatum*, St. Ignatius and Hairy Giza 36 were also carried on.

Major hairiness in cotton always appears to be controlled by a main gene, stepped up either by minor genes or by intensifying genes or both.

For breeding purposes the gene H_1 has been chosen as the most hopeful one around which to build synthetic jassid resistant Sakels. This gene was chosen partly because it is common to *G. barbadense*

* The "chlorophyll deficient" of Harland (1932)—ED.

(Tanguis and Carpulla) and *G. hirsutum* (MU8b and St. Ignatius), but also because it has proved to have no deleterious effects on lint quality. This was shown in last season's Report (p. 65) by means of a comparison of JR.14/5 (carrying H_1) with Evelyn's Sakel.

In almost all of these jassid resistance transferences, therefore, it will be necessary to have, as a recurrent parent for the last few backcrosses, a Sakel homozygous for H_1 and at the same time resistant to leafcurl and blackarm. This has now been made by backcrossing JR.14/5 to BAR.14/7 and latterly to BLR.14/16 and the new strain will be in small bulk next season under the number BLJR.14/23. It is not intended that this shall ever become a commercial strain—it has been made solely for use as a backcross parent and although it will ultimately go into variety tests in the Gezira, the objective will be solely to make sure that BLJR.14/23 is fully up to expectation in every way.

Following BLJR.14/23 is a wave of material carrying both B_2 and B_3 and this will form the ultimate backcross parent in this work.

Transference of lint strength from G. thurberi to Sakel.

The Shirley Institute's Report on the samples of (*G. "thurbadense"* x Sakel³) x BAR.14/7 F_1 , sent there last season, showed that the extra strength derived from *G. thurberi* had been lost. This was not unexpected since, in the previous season, the hybrid parents had suffered such a severe attack of leafcurl that they became useless as female parents and had to be used as males in backcrossing. Pollen grains carrying an extra (*thurberi*) chromosome would probably be at a disadvantage in fertilization and this is almost certainly the reason for the loss of the extra strength.

This season, therefore, seed of 1947 origin was sown to recover the extra strength from this earlier material. Hand tests of the material suggest that the strength is in fact present, and lint has been sent to the Shirley Institute from 19 plants, selected as being the strongest in the (*G. thurberi* x Sakel⁴) x BAR.14/7 F_1 families, and from 65 of the strongest plants in the *G. thurberi* x Sakel⁴ F_2 's.

YIELD.

Apart from the provision of disease resistance by hybridization, the improvement of the yielding capacity of X.1730 and Sakel is largely a matter of straight selection, and such selection is in fact being carried out at Medani. Nevertheless it seems probable that the process can be helped by hybridization. Thus one of the characters on which yield is ultimately based is the number of locules per boll. The transfer of 4-loculed bolls to Sakel will not necessarily increase yield immediately, but such a Sakel would obviously offer more scope for selection for high yield.

Accordingly this 4-loculed character is being transferred to BLR.14/16. This season, the character was successfully transferred to the 3rd Sakel backcross stage from tetraploid *G. herbaceum*, and also from tetraploid *G. arboreum*, and to the 4th backcross from *G. hirsutum* (Ferguson). Further backcrosses were made in each case and these will be sown next season.

A second possibility for augmenting the capacity of a strain to respond to selection for increased yield, is to raise the number of seeds per locule. With this end in view, seed of *G. auritum* has been obtained from America. This "species" has 12-13 seeds per locule and it is intended to try transferring some or all of this increased number to Sakel (which normally has 6-7).

DISEASES AND PESTS.

Leafcurl was moderately severe though less so than last season.

Pink and Egyptian bollworms were very troublesome.

Jassid caused heavy bud and boll shedding and leaf mortality during the first half of the season.

Rhizoctonia wilt was more widespread than it has ever been during the last 21 years at Shambat. This spread is probably attributable to the use of a tractor for ploughing and cultivation.

PUBLICATIONS.

KNIGHT, R. L., 1949. The distribution of wild species of *Gossypium* in the Sudan. *Emp. Cott. Gr. Rev.*, 26, pp. 278-285.

KNIGHT, R. L. The genetics of jassid resistance in cotton. I. The genes H_1 , H_2 and H_3 . *J. Genet.* (in press).

KNIGHT, R. L. The genetics of withering or deciduous bracteoles in cotton. *J. Genet.* (in press).

SUMMARY AND CONCLUSIONS.

This season the production of a blackarm (B_2) and leafcurl resistant Sakel was completed and a small quantity of seed of $B_2 B_3$ Sakel was sown for bulk propagation. This latter type will be rendered leafcurl resistant next season.

Blackarm resistance breeding is complete in the X.1730 type as regards hybridization and the $B_2 B_3$ product is now undergoing reselection at Medani.

In breeding for jassid resistance, backcrossing is being done to BLR.14/16, the blackarm and leafcurl resistant Sakel. Here it has been shown that the full hairiness of some of the hairiest Uplands can be transferred to the Sakel genotype. Full hairiness has been carried to the 3rd backcross F_2 stage and further backcrossing and selfing out will continue.

The four-loculed boll character was successfully transferred to the 3rd backcross from *G. arboreum* and *G. herbaceum* and to the 4th backcross from Upland. The recurrent parent used in these transferences was blackarm and leafcurl resistant Sakel.

CYTOGENETICS

BY

H. DOUWES AND R. L. CUANY

Relationship of Wild and Cultivated Species.

The systematic study of the response of Demak, a strain of *G. arboreum* race *burmanicum*, from Java, to varying dosages and lengths of treatment with colchicine has been concluded. A full description of these experiments will be submitted for publication elsewhere. A method was devised for treating the growing point of a germinating seed without damaging the root tip, and this has been used for synthesising tetraploids from crosses of Asiatic cottons with New World wild species. The synthesis, *G. arboreum* $\times$ *G. raimondii*, has given one tetraploid hybrid up to now of which the Asiatic parent is *G. arboreum* race *bengalense* (Mollisoni). It is growing vigorously and flowering profusely, and though at first sterile both by self and by cross pollination, it is now setting bolls freely. The chromosome pairing seems to be fairly normal.

Asiatic $\times$ *armourianum*. Some seeds have been obtained, but the ones sown up to now proved all to be empty.

G. gossypoides $\times$ Asiatic. 663 seeds were obtained from crosses of *G. gossypoides* on to a range of types of *G. herbaceum* and *G. arboreum*. Of these the vast majority were empty, the only germinated seeds available for colchicine treatment, 40 in number, were all found to be diploid or tetraploid Asiatic when grown, and were not hybrids with *G. gossypoides* at all.

G. thurberi $\times$ Asiatic. As noted in last season's report (p. 4) the amphidiploid 2 (*G. thurberi* $\times$ *G. arboreum*) has been available from Trinidad, and extensive material derived from a cross between the amphidiploid and a Sea Island strain carrying the "superokra" factor for very narrow leaf shape has been studied in seasons 1948-49 and 1949-50. Unfortunately, eye classification of leaf shape is unsatisfactory, and measuring and the subsequent analysis of the figures is a long process. In selfed lines the segregation of the two parental genes for leaf shape is somewhat disturbed and difficult to analyse. It appears that the *thurberi* D genom is sufficiently unlike the Upland D component to upset the mechanism, although cytological examination of hybrids between the amphidiploid and the New World cottons shows no abnormality worse than an occasional single quadrivalent. The leaf-shape gene of *thurberi* origin is being transferred to a *barbadense* and a *hirsutum* background by backcrossing, and when the background is stable enough, the unplaced leaf shape gene will be tested to locate it in either the D or the A genom. During the backcrossing, inheritance of other characters such as hairiness and especially lint strength will be studied.

From the older material 120 plants having noticeable lint strength were selected by pulling in the field, and further selection was done in the laboratory, leaving 17 plants whose lint has been sent for objective strength testing to the Shirley Institute. Samples of the parents and early hybrid generations were sent as controls.

Attempts to repeat the synthesis of the amphidiploid 2 (*G. thurberi* $\times$ *G. arboreum*), using Asiatic stocks carrying recessive genes, have met with no success, and were discontinued in favour of using *G. raimondii* for such work.

Relationships of Wild Species. *G. areysianum* was received in June 1949 in large quantity, through the courtesy of the Director of Agriculture, Aden. The seeds germinated well and gave vigorous plants whose habit resembles *somalense* rather than *anomalum*, in being tall and having a prominent main stem. The leaves are broad-lobed as *somalense*, while the flowers are pale yellow with a clear red basal spot, again resembling *somalense* rather than *anomalum*. Seed has been obtained from crosses of *G. areysianum* as one parent and *G. stocksii*, *G. somalense*, and *G. anomalum* respectively as the other. If hybrid plants can be raised from this seed then the cytological relationship between *G. areysianum* and the other species will be examined.

G. triphyllum was received from A. Cabral Nabais in May 1949, the few seeds having been collected on the borders of the Cunene River in Angola 14° 18' S. Two plants were obtained which have a rather dwarf habit and glaucous trifid leaves. The flower is very pale mauve, with a deep purple spot at the base, as in *anomalum*. The chromosome number has been determined as $n = 13$. Crossing is in progress with the same species as are being used for *G. areysianum*.

G. anomalum has been received for the first time from its Southern African area. The three collections are from :—

Angola : Borders of Cunene River. Lat. 14° 18' S.

S.W. Africa : Namib Desert, between Kuiseb and Franzfontein.

S.W. Africa : Seed from specimen in the National Herbarium, Windhoek.

Each of them is similar to the types found in the Sudan belt across Africa, except in having the petal flushed with pink, instead of pale mauve, almost colourless. Crossing is in progress to test these differences.

G. sturtii has been further represented by two accessions through Dr. R. A. Silow coming from Central Australia and New South Wales. The former resembles very closely the type already in our collection, while the latter has a more open habit with smaller, slightly puckered leaves, and corky branches instead of the bark remaining green.

G. robinsonii was received at the same time as the above *G. sturtii*, having been collected by C. A. Gardner along the Fortescue

River in Western Australia (118° E. 22° S.). Six plants are growing but only vegetative characters have been observed. The habit of the plant is tall and pyramidal with sparse branches, quite unlike the dense bushiness of *sturtii*. The leaves are about 4/5 cut into 3-5 lobes, less waxy than those of *G. sturtii*, but with a variable number of nectaries situated not at the base of the main leaf veins, but towards their apices; the nectar is bright red.

With the accession of *G. areysianum*, *triphyllum* and *robinsonii* to the Type Collection, the only species mentioned in Dr. J. B. Hutchinson's classification (1947) which is still not represented is *G. trilobum* and doubt exists whether this is specifically distinct from *G. gossypoides*.

G. gossypoides has been growing since 1947, but the crossing programme was discontinued, to try and obtain some selfed seed. Crossing will be resumed as opportunity offers. The following table shows how little success has been obtained in crossing up to now, except where *G. anomalum* and *G. thurberi* were the female parents.

Genom.	Female Parent.							Flowers Pollinated.	Bolls collected.
B	<i>G. anomalum</i>	...	...	...	...	...	...	452	52
C	<i>G. sturtii</i>	...	...	...	...	...	...	1	—
D	<i>G. thurberi</i>	...	...	...	...	...	...	27	4
D	<i>G. armoirianum</i>	...	...	...	...	...	...	20	—
D	<i>G. klotzschianum</i>	...	...	...	...	...	...	7	1
D	<i>G. raimondii</i>	...	...	...	...	...	...	38	—
D	<i>G. stocksii</i>	...	...	...	...	...	...	149	4
E	<i>G. somalense</i>	...	...	...	...	...	...	57	—

The seeds are now being germinated, and such as grow to flowering will yield cytogenetical data on the relationship of *G. gossypoides* to the rest of the genus.

Related genera. Seed of the genera *Notoxylinon* and *Alyogyne* was received from Australia, but only that of *Notoxylinon australe* proved viable.

GENETICS.

Rogues in Egyptian Cotton.—Rogues of high node-number, and curly-leaved types were studied but gave no clear results; certain crosses are being carried further to test the nature of the curly rogue, and to maintain the type for future studies if more important work allows. No cytological abnormality has been seen.

A smooth-bolled rogue, without the usual dense black mottling with oil glands, was grown and crosses made to an American Sea Island carrying a similar character, to detect if the same gene-mutation has occurred. Crosses will also be made to an Upland type UA 5-3 which has the oil glands arranged in stripes on the boll. These characters may be useful as marker genes.

Blackarm Genes.—Study of linkage between B_2 and B_3 has started with the production of F_1 progenies between *barbadense*, Upland, and *punctatum* types, and within these types. It is suspected that the interspecific linkage test may show closer linkage owing to

reduction of crossing over between non-homologous segments. This close linkage has been found by Dr. R. L. Knight to break down after 3-4 generations of backcrossing.

In the search for linkages with B genes to facilitate homology studies, flower, leaf, habit and lint characters are to be tested against the different B genes. In order to bring out clearcut segregations the characters under consideration are first brought into the same genetical background by backcrossing them to XI730A.

Tests of the basis of resistance in highly resistant West African *punctatum* types, moderately resistant Bahamas *punctatums* and Acala UA 2-15 have commenced with the crossing on to susceptible XI730A. The resistance of Stoneville 20 is being studied by Dr. Knight but a check cross has been made between it and Acala UA 2-15 to determine if the same gene is involved.

The genes causing resistance in Nigerian Allen, Samaru 26C and N'Kourala (from French Ivory Coast) are being studied in the same way. Several generations of backcrossing to susceptible XI730A are followed by test crosses with known genes. Meanwhile the above three stocks have been made homozygous in their blackarm resistance for further selection in individual territories.

The transfer of B₂ and B₃ to Wilds 16 has reached its first back-cross, and in addition hairiness is being transferred from MU.8b to Wilds 16.

Asiatic Linkage Tests.—The F₁ hybrids involving the genes in the linkage groups Lc₁^k—Li₄—Cu—L and P—Ne have been made and selfed and backcrossed to a type of *G. arboreum* race *indicum* as a uniform background. When the tester stocks have been made, the linkage within *arboreum* and between *arboreum* and *herbaceum* will be analysed. The blackarm gene B₄ will not be studied as grading on the *arboreum* background is very difficult.

Miscellaneous.—The mutant gene “virescent bud” (v₁) first reported by C. P. Yu, has been found in an *arboreum* from the Philippines.

A homology test of the red-leaf gene in Acala Red (Upland) against known R₁ types, and of a mahogany lint gene in a *barbadense* are in progress. Multiple dominant and multiple recessive marker stocks in Upland were received from Dr. S. G. Stephens in U.S.A. The maintenance of gene types for use in linkage and other studies is a part of the Corporation's Genetics Programme.

TYPE COLLECTION.

New accessions are continually being added to the Type Collection, as they are grown and classified. This season's additions are 13 from Central Mexico, 1 from the Dutch West Indies, 7 from the Sudan and some 30 from Portuguese East Africa and Angola. The latter are being used in a study of the racial status of *G. herbaceum* race *africanum*. Wild species have been noted under Section 1 of this report.

It might be mentioned that Dr. Hutchinson brought with him on his return from England in October 1949 seed from 10 different strains of Upland cottons that were grown on a commercial scale in South Africa in the twenties. The seed had been stored in small glass tubes at the Shirley Institute, and from the labels it appears that the seed must have been from the 1923-24 crop. From the total of about 500 seeds only a very few germinated and from these two plants were grown to maturity. One is a specimen of the variety Griffin and the other of Watt's Long Staple. Selfed seeds have now been grown of both specimens and are available for comparative studies if other stocks of these varieties still exist.

LINT PHYSIOLOGY.

Boll samples have been sent by air to Manchester University where Mr. A. Swaffer is studying the development of lint hairs.

CYTOGENETICS PROGRAMME 1950-51.

All the lines of work shown in the above report are being continued, except where otherwise indicated.

In addition, an attempt will be made to transfer genes for bollworm resistance and for increased lint strength from the D genom to the A genom, if necessary through crossing with the B genom (*G. anomalum*), with which both A and D genoms are partially interfertile.

KADUGLI STATION

BY

M. F. ROSE.

METEOROLOGY.

The complete absence of rain in April and the relatively heavy rains in May were the prelude to the poor and sketchy planting rains of June and early July. The timely precipitation of 40 mm. on July 25th saved all breeding stock and field experiments (planted on June 26th) and was really the first good planting rain of the season. From this date the sequence was excellent and those areas which had survived the early drought returned good yields. Late October rains (46.5 mm. on October 19th) raised the level of both yield and quality and final returns from the Kamina Farm averaged 1,500 lb. of seed cotton per acre. Outlying areas from Kadugli experienced the same trend of rainfall conditions and much of the early crop was drought-stricken and subsequently abandoned. Relevant data for the season are presented in Table I.

TABLE I RAINFALL (MM.) KADUGLI.

	<i>Feb.</i>	<i>Mar.</i>	<i>Apr.</i>	<i>May</i>	<i>June</i>	<i>July</i>	<i>Aug.</i>	<i>Sept.</i>	<i>Oct.</i>	<i>Nov.</i>	<i>Dec.</i>	<i>Total.</i>
1910—1948 ...	2	1	15	78	123	151	154	138	81	6	—	749
1949 ...	—	—	—	113	82	99	158	169	117	—	—	738

	<i>Mean Max. °F.</i>	<i>Range °F.</i>	<i>Mean Min. °F.</i>	<i>Range °F.</i>
Resting Period : Dec.—May ...	98	111—80	69	86—53
Growth Period : June—Nov. ...	91	102—73	68	82—50

COMMERCIAL COTTON.

In view of the issue of 23,000 kantars* of seed for the 1949-50 season and the eagerness of the cultivator to obtain as large a quota as possible, high hopes were entertained for a marked increase in seed cotton production over the previous season's figure of 201,000 kantars. Assuming that the bulk of the seed issued would be planted, an increase of over 70% had been confidently expected. Final figures (March 1950), however, for the 1949/50 cotton markets showed an actual return of only just over 201,000 kantars.

The following causes may be said to have contributed to these disappointing returns :—

- (i) Badly distributed rains and poor planting conditions up to July 25th, with the result that much of the crop planted before this date was lost.
- (ii) Very late replanting (mid-August) with the inevitable reduction in final yield.
- (iii) Very severe damage from Sudan, Egyptian and Pink bollworm.

* 1 kantar=99 lb.

- (iv) Poor conditions generally being superimposed on badly-filled seed from the previous season (the worst on record).
- (v) Greater attention being paid to the dura crop (due to anticipated food shortages) and consequent neglect of the standing cotton crop.
- (vi) Shortage of pickers in November and December and the loss of much seed cotton on the ground.

COTTON SELECTION.

The breeding plot comprised the following four groups: BAR SP.84 (104 progeny rows), CL 20-4 (5 progeny rows), MZ 561 (4 progeny rows), Wilds 11 ex Zeidab (67 progeny rows). Small special bulks of A2106, A220 and A292 (U4 x Cambodia) and A332, A449 and A455 (U4 x MU8) were also included for observation, their type being maintained by selfing. The six groups have been fully described in the 1948-9 Report in which the general policy towards each was formulated. All material was badly affected by the early season's drought and had to be maintained by hand watering. From July 25th, however, excellent conditions prevailed and the late October rains did much to improve general quality: individual plant yields were well above average.

In BAR SP.84, 43 progeny rows have been retained for subsequent work: it is apparent, however, from field observation and laboratory analyses that there is a marked levelling-up (both within and between lots) of the more important characteristics and that the variability for future selection work must be sought elsewhere. To this end an extensive crossing programme was undertaken, involving the eight nuclei already derived from BAR SP.84 and variety BAR NT.96/40 (*vide* Cotton Hybridisation).

In spite of their earliness, 8121 derivatives (ex type MZ 561) have been discarded in favour of 8131 and 8134 (ex type CL 20-4). Under local conditions they have failed to approach the latter in yield potential (*vide* miscellaneous V.T.) and spinning qualities.

Of the 67 progeny rows from Wilds 11, nine have been retained: their mean node numbers range from 5.8-6.2. A comparison of the overall node number (mean) for season 1948 with that of 1949 (mean node number from the 67 progeny rows) indicates a value constant at 6.5. Figures from the 1950 season will be of interest and should give some indication whether this line of work merits further pursuit.

The three U4 x MU8 derivatives, although yielding slightly less than their Cambodia counterparts, have again proved earlier and more mature in fibre characters. They seem better adapted to the short growing period of the Kadugli area and will be tested in variety trials against the best BAR SP.84 selections in the 1950/51 season. A2106, A292 and A220 will be dropped.

COTTON HYBRIDISATION.

Plants typical of the strain BAR NT.96/40 were crossed with the eight nuclei from BAR SP.84, Nos. 853, 857, 840, 841, 891, 861, 862 and 836. BAR NT.96/40, originally derived from the cross 57 x Over-the-Top and rendered homozygous for B_2 , has had a good record in the Jebels area and although a mid-season type is not so late as the old commercial Pump Scheme Strain. Over a number of seasons and localities, its mean fibre characters do not differ markedly from those of BAR SP.84 although its standard hair weight tends to be slightly higher. It is very prolific, big-bolled and a clean opener and the transfer of its robustness and vigour to the more delicate type BAR SP.84 is the first essential of the cross. Sixty individual crosses were made with each pair, and with reciprocal crossing, the programme has given 16 lots of F_1 seed for the coming season.

Four further lots of F_1 seed are available, derived from the inter-strain crosses 840 x 862 and 841 x 857 (direct and reciprocal). It is hoped to transfer the excellent fibre properties of the finer-wooded types 840 and 841 to the stronger-wooded, more robust types 862 and 857.

PROPAGATION OF COMMERCIAL STOCKS.

(a) Isolated plots (1/20th acre each) of the eight strains selected from BAR SP.84 were planted out on June 26th. Adequate seed is available from each for a bulking-up programme at El Effain in the coming season.

(b) An area of 230 acres of BAR 7/8 (a BAR SP.84 derivative homozygous for B_2 and B_3) was planted out at Gannaya, 20 miles north of Kadugli. In spite of late planting (mid-August), the crop appeared healthy and vigorous and in early November showed very marked resistance to blackarm. Toward the end of the month, however, there appeared a falling-off in this resistance, but even so its superiority to the commercial bulk (BAR SP.84) in adjacent areas was strongly in evidence. The type was very heavy fruiting and figures to date indicate a minimum return over the whole area of 500 lb. of seed cotton per acre. In view of the conditions under which the crop was grown, such an average return is good.

The yielding capacity of BAR 7/8 has also been demonstrated in the Miscellaneous V.T. (see Cotton Testing) and its superiority to BAR SP.84 in blackarm resistance has been amply demonstrated in controlled spraying experiments (see blackarm). Though its lint is slightly shorter than that of BAR SP.84, there is evidence that this defect can be remedied by selection within the crop. Four hundred and thirty single plants were taken from Gannaya for filtering, and laboratory figures indicate a promising degree of variability. Final judgment on this type must be reserved, however, until data from large scale spinning tests are available.

COTTON TESTING.

In spite of bad conditions and heavy bollworm attack, the Intra-BAR SP.84 V.T. and the Miscellaneous V.T. (planted on June 26th)

gave mean returns of 560 and 594 lb. of lint per acre respectively. Relevant data are given below followed by a short discussion of the strains in question.

TABLE II.

<i>Intra-BAR.SP.84 V.T.</i>			<i>Miscellaneous V.T.</i>		
<i>Strain.</i>	<i>G.O.T.</i>	<i>Lint per acre (lb.)</i>	<i>Strain.</i>	<i>G.O.T.</i>	<i>Lint per acre (lb.)</i>
861... ..	35.9	677	8134	32.1	644
BAR.SP.84S ...	34.9	598	BAR. 7/8	35.0	623
BAR.SP.84 ...	33.1	570	BAR.SP.84	33.6	620
853	36.1	554	8131	31.8	619
862	34.6	548	8121	29.8	580
857	35.9	531	BAR.NT.205/47 ...	36.7	553
840	34.1	529	BAR.NT.205/43 ...	32.8	516
836	33.1	521			
841	34.2	516			
Diff. required for 5% level=47 lb.			Diff. required for 5% level=77 lb.		

In the Intra-BAR SP.84 V.T., strain 861 outyielded the parental bulk by 107 lb. of lint per acre, an increase of 19%. Further proof of its high yielding capacity was given by its nucleus (1/10th acre) which returned 572 lb. of lint per acre, outyielding its nearest competitor, 862, by 30%. There can be little doubt about the yielding capacity of this strain, but as regards strength and maturity it falls well below 840 and 841. These quality types, unfortunately, appear well down in the list of final yields. BAR SP.84 S (BAR 7/3) selected directly from BAR SP.84 for its higher G.O.T. has not significantly outyielded the latter.

In the Miscellaneous V.T., 8134 (ex CL 20-4) heads the list with 644 lb. of good quality lint per acre. Owing to the high error of the experiment, it outyields significantly only the two varieties BAR NT.205/47 and BAR NT.205/43: these latter (ex SP.20) were of U4/4/2 origin and were originally considered as potential rivals of BAR SP.84: the yield from 8121 (ex MZ 561) is disappointing and in view of the gradual falling-off in its lint quality this strain has been dropped.

Multifactor Experiment.—The results from a 3⁴ Experiment, planted on July 20th are given in Table III. Owing to the erratic rainfall, the planting date was unavoidably late and this fact combined with heavy bollworm attack reduced the mean yield of the experiment to 210 lb. of lint per acre.

TABLE III.
BAR.SP.84—TREATMENTS AND MEAN YIELDS IN LB. LINT PER ACRE.

<i>Seed Rate</i>					
r0 = 10 seeds per hill at planting	...	...	...	...	216
r1 = 15 " " " " "	...	...	...	...	207
r2 = 20 " " " " "	...	...	...	...	208
<i>Thinning Date</i>					
t0 = Thinned to 6 at 15 days, final thinning at 25 days					211
t1 = " " " " 25 " "					209
t2 = One thinning only, at 35 days (native practice)					210
<i>Intra-Row Spacing</i>					
s0 = 45 cms.	...	...	...	...	237 (136%)
s1 = 60 cms.	...	...	...	...	219 (126%)
s2 = 90 cms.	...	...	...	...	174 (100%)
<i>Final Hill Stand</i>					
h0 = 2 plants	...	...	...	...	191 (89%)
h1 = 3 plants	...	...	...	...	214 (100%)
h2 = 4 plants	...	...	...	...	225 (105%)

SE = ± 4.8 .

No first order interactions significant—values therefore omitted.

For the fourth consecutive year the superiority of the closer spacing (45 cms.) over the wide commercial spacing (90 cms.) has been demonstrated, the present season's increase being of the order of 36%. The figures also support the high interaction value of Variety x Plants per hill (V.H.) of the previous season's experiment, in which it was evident that the finer wooded type, BAR SP.84, could tolerate a higher hill population than the stronger wooded, coarser types, Pump Scheme and BAR NT.96/40.

The almost significant difference in favour of the lowest seeding (10=10) can be accepted only in terms of the excellent sequence of rains following the planting of the experiment. On the breeding plot, where every endeavour is made to create an ideal seedbed, only 2 to 3 seedlings may be expected to emerge from 10 acid-treated, water-sinking seeds planted, if planting is not followed by rain. Hot, drying winds can pan down the surface to the consistency of concrete and a light seeding fails to emerge. The cultivator, well aware of the local soil type, throws in a handful of seed ranging from 15 to 25; without following rains such a seeding can break the surface crust and give fair stands but under such circumstances intra-hill competition becomes acute at a very early stage and the young seedling is adversely affected. On these black clays it is obvious that a balance must be struck between the opposing requirements of stand and subsequent seedling development.

Eleven days from planting date, germination counts were made over the 3 levels of seed-rate and such figures converted to *percentage* emergence; for 10, 11, 12, these were shown to be 70.5, 73.3 and 54.3 respectively. The fall in emergence percentage with the highest seed-rate is highly significant and points to an adverse conditioning of the seedling at a very early stage.

The prescribing of a fixed seed-rate to meet the varied demands of both soil and season is difficult but past experience indicates that the planting of 15 seeds per hill will meet average requirements. At this seed-rate and the commercial spacing of roughly 1 metre x 1 metre, the cultivator is fully justified in demanding seed at 18 lb. per acre (14 lb. planting plus 4 lb. gap-filling) and any attempt to reduce this figure would be false economy.

With the very high seeding per hill necessitated by soil type, early thinning becomes of primary importance. Fearing damage by white ants, grasshoppers and millepedes, the cultivator postpones the thinning of his "clumps" to the latest possible date and then thins in one operation. Although not demonstrated in the present experiment, such a practice produces a leggy type of plant and adversely affects final yield. Under local conditions, treatment tO has been accepted as Standard Practice.

DISEASES AND PESTS.

Blackarm.—In general, blackarm was in evidence in the commercial crop throughout the season and most markedly in those areas where planting had been delayed until mid-August. Its

intensity and spread can be more closely followed in Table IV which lists resistant, very resistant and susceptible varieties. As in the season 1947-8, the gene B₂ was hardly sufficient to cope with the worst conditions of infection but under such circumstances BAR 7/8 (B₂ B₂ B₃ B₃) offered excellent resistance; although planted in August (Gannaya) this type gave seed cotton of marked cleanliness, even in the late pickings. The figures shown in Table IV were obtained from sprayed guard rows in the Miscellaneous V.T. (planted June 26th: sprayed August 15th) and indicate the general development of the disease as the season advanced.

TABLE IV.

Date.	Variety.	% infected.	Mean B.A. Grade.	
1st Count Aug. 31st	BAR.SP.84	21.0	4.7	Approx. 500 plants counted per strain per occasion.
	BAR.SP.84 S	3.2	4.6	
	BAR. 7/8	—	—	
	Pump Scheme	100.0	8.0	
2nd Count Sept. 9th	BAR.SP.84	38.8	5.7	
	BAR.SP.84 S	20.4	4.6	
	BAR. 7/8	3.5	3.7	
	Pump Scheme	100.0	9.0	
3rd Count Sept. 18th	BAR.SP.84	73.9	4.5	
	BAR.SP.84 S	66.5	4.3	
	BAR. 7/8	11.0	3.6	
	Pump Scheme	100.0	9.2	

On the 3⁴ Experiment, late planted on July 20th with BAR SP.84, figures showed 100% infection with a mean blackarm grade at 6.7. Such a degree of infection was equivalent to that on all late plantings in the area and gives a fair measure of the general intensity of the disease.

Bollworms.—The present season was probably the worst on record for bollworm attack. Sudan and Egyptian made their appearance in the crop in early August and losses from these two pests continued to the end of the growing season. The early crop was either completely lost or so badly damaged that quality was seriously impaired: down-grading was severe in all early markets.

Regarding Pink bollworm, boll samples taken from the Main and Kamina Farms on November 15th showed an infection figure of 54% and 35% respectively. Taken in conjunction with the date, these figures are very serious.

With the rapid expansion of the commercial crop, there has been a proportionate increase in the area of standover cotton and to this can be ascribed the severe damage found in the 1949/50 crop. If cotton is to survive future attacks, area-hygiene methods are an absolute essential and a rigorous cutting-out campaign must be formulated and followed during the dry season. A conservative estimate of crop loss through bollworm on the Main and Kamina Farm is 30%.

Flea-beetle (Podagrica puncticollis).—Damage to the young crop by flea-beetle was controlled by dusting with DDT powder. This pest, however, was most persistent throughout the whole season and marked puncturing of leaves was in evidence up to the closing down of the crop.

Cotton Leaf Roller (*Sylepta derogata*).—The pest made its appearance in early August and persisted in the crop until the end of October. Outside areas suffered severely but on experimental sections the pest was controlled by the plucking of infected leaves.

Stainers (*D. fasciatus* and *superstitiosus*).—The first migrants appeared in experimental cotton on September 25th: the subsequent population did little damage, and in the Kadugli area the commercial crop showed little signs of "true" staining.

OTHER CROPS.

Commercial stocks of four early, eleven mid-season and four late types of dura were maintained by appropriate methods: of the seven special bulks of lubia helu (*Vigna Unguiculata*) 3 lots—Kadugli 4, 3 and 47—have been retained for bulk propagation. They are resistant to the local leaf mosaic and cover the range of types required for the Jebels area. They can be shortly described as (i) Kadugli 4—a late fodder type, red grain, (ii) Kadugli 3—mid-season, dual purpose type, brown grain, (iii) Kadugli 47—an early type, white grain. The two simsim varieties, Kadugli Resistant White and Kadugli Early Resistant White were maintained in one acre blocks. The demand for these types, resistant to the local Marad ed Dam disease (*Bacterium sesami*) has far exceeded available supply. Small areas (1/5th acre) of the four groundnut varieties, Barberton, Medani Erect, American Erect and Abu Arba were also grown.

SUMMARY.

(i) An erratic, early rainfall with light and sketchy planting rains was responsible for the loss of much of the early crop. The first good planting rain of 40 mm. was recorded on July 25th: from this date ideal conditions for growth prevailed until the end of October.

(ii) The returns from the commercial crop were disappointing, with a final yield of 201,000 kantars. This is practically the same as the previous season's figure: such poor returns can be ascribed to (a) poor early rains in which much of the crop was lost, (b) subsequent late plantings in which yields were inevitably reduced, and (c) severe bollworm attack which reduced yields generally by 30%.

(iii) Material in the breeding plot has been listed and the crossing of BAR NT.96/40 with the eight nuclei from BAR SP.84 has been described. A filter of 430 single plants of BAR 7/8 from Gannaya has been made in an attempt to raise the length and lint quality of this very resistant blackarm type.

(iv) Data from two variety trials (Intra BAR SP.84 and Miscellaneous) have been presented. In the former, strain 86r yielded 677 lb. of lint per acre outyielding the parental bulk by 107 lb. lint (19% increase). The yields of all the "quality" types were below that of the parental bulk, though in four cases not significantly so.

In the Miscellaneous V.T., 8134 (CL 20-4 ex Nyasaland) returned 644 lb. of lint per acre, a non-significant increase of 24 lb. lint over BAR SP.84.

(v) The results from a 3⁴ Experiment have been presented : for the fourth year in succession the close intra-row spacing of 45 cms. has significantly outyielded the wider commercial spacing of 90 cms., in this case by 36% : regarding plants per hill at final thinning, yields increased directly with hill population, all possible comparisons being significant.

A short note has been made on the relationship between seed rate and soil type : attention has also been drawn to the importance of early thinning with high seed rates.

(vi) Blackarm in the commercial crop has been discussed and its development and spread through susceptible and resistant varieties has been followed : blackarm counts on three occasions have demonstrated the marked resistance conferred by the genes B₂ and B₃ in type BAR 7/8.

(vii) Special stress is laid on the importance of area-hygiene methods ; stringent regulations for cutting out old cotton stalks must be enforced, entailing conscientious survey work in the main cotton areas. Without such precautions the future cotton crop will succumb completely to bollworm attack.

PROGRAMME FOR SEASON 1950-51

COTTON.

Breeding Plots.

1. *Selection Work—*

- (a) 9 Special bulks of BAR SP.84 for type maintenance.
- (b) 84 progeny rows of Wilds 11.
- (c) 31 „ „ „ BAR 7/8 (for type maintenance).
- (d) 15 „ „ „ „ (for type improvement).

2. *Hybrid Seed.*—Inter-varietal and inter-strain crossing. 20 lots of seed.

Testing for Yield and Quality :—

1. *Miscellaneous V.T.*—BAR SP.84, BAR 7/8, BAR 7/3.

449, 455, 332 (ex S. Africa).

8131, 8134 (ex CL 20-4).

Pump Scheme Strain (Control).

Nine Varieties x 5 replications.

2. *Intra-BAR SP.84 V.T.* :—

Strains 836, 840, 841, 853, 857, 891, 861, 862 and BAR SP.84 (Control).

Replicated as above.

Manurial.—3 x 3 x 3 Expt. : three levels of N.P. and K as supplied by nil, 150 and 300 lb. of fertiliser per acre. Fertilisers $(\text{NH}_4)_2\text{SO}_4$, Superphosphate and K_2SO_4 .

Small Scale Propagation.—Areas of 1/20th acre of

(a) 449, 455 and 332 (U4 x MU8).

(b) 8131, 8134 (ex CL 20-4).

Large Scale Propagation.—Areas of 1 acre each at El Effain of 841, 836, 891, 861, 853, 857, 840, 862.

OTHER CROPS.

Dura : Breeding.—Type maintenance by appropriate methods of 4 Early, 11 mid-Season and 4 Late lots.

Groundnuts.—Type maintenance of Barberton, Medani Erect, American Erect and Abu Arba. (1/8th acre of each).

Simsim.—Type maintenance of Susceptible Red, Resistant White and Early Resistant White.

Lubia helu (Vigna spp.).—Bulking up in 3 acre blocks of Kadugli 3, 4 and 47.

APPENDIX.

KEY TO SYMBOLS USED IN THIS REPORT.

Varieties :—

A 220.	} (U.4 x Cambodia).
A 292.	
A 2106.	} (U.4 x M.U.8).
A 332.	
A 449.	
A 455.	
B 31.	A blackarm resistant Upland type from Uganda.
BAR.NT.96/40.	NT.96 carrying B_2 (American Upland).
BAR.NT.205/43.	Selected from Uganda SP.20 and homozygous for B_2 .
BAR.SP.84.	The blackarm resistant component of Uganda SP.84.
BAR.SP.84 S.	Material selected by Knight from BAR.SP.84 for G.O.T. = (BAR.7/3).
BAR.4/5.	9th backcross X.1730 homozygous for B_2 .
BAR.4/11.	X.1730 carrying both B_2 and B_3 .
BAR.7/3.	Selection from BAR.SP.84 for improved G.O.T.
BAR.7/8.	Blackarm resistant SP.84 carrying B_2 and B_3 .
BAR.14/1.	5th backcross BAR.2/10 x Domains Sakel homozygous for B_2 .
BAR.14/19.	6th backcross of Evelyn's Sakel homozygous for B_4 .
BAR.14/21.	(BAR.14/9 x BAR.14/7) x BLR 14/16 $B_2 B_3$.
BLR.14/16.	Selections for leafcurl resistance made from BAR.14/7.
BLJR.14/23.	Blackarm leafcurl and jassid resistant Sakel.
BAR.1730L.	7th backcross X.1730A homozygous for B_2 .
BAR.1730L	BAR.1730L which has been " filtered ".
Sels. 1 & 2.	
BP.52.	A direct import from Uganda.

Cambodia.	American long staple imported from Barberton.
Domains Sakel	} A standard variety originally imported from Egypt.
Dom. Sak.	
D.S.	
DS ₁ , DS ₂ , DS ₃ .	Selections and reselections by Evelyn from Dom. Sakel.
Dom. Sakel	" Filtered " Domains Sakel.
Sels. 1 & 2.	
Ferguson.	A hairy Upland obtained from the Philippines via Trinidad.
JR.14/5.	Evelyn's Dom. Sakel to which H ₁ has been transferred from Tanguis.
JR.1530.	Selection from within 1530 for hairiness.
K.	Large Kantar=312 lb. but in Kordofan and Tokar=99 lb.
Kapas Pura.	Densely hairy cotton from the Philippines via Trinidad (U.A-7-47).
" L " Cotton.	The X.1530-X.1730 group of cottons.
MU8b.	A hairy Upland from India.
NT.96/40.	57 x " Over-the-top ", a single plant selection made by Anson.
NT.205/41.	A selection from Uganda SP.20 made by Anson.
NT.205/43.	Successor types to NT.205/41, above, carrying B ₂ .
NT.205/45.	} Successor types to NT.205/41, above.
NT.205/47.	
Pump Scheme Strain.	Commercial type which originated from Nyasaland Upland.
RDS.	Leafcurl resistant Sakel.
" S " Cotton.	Domains Sakel.
SFD-5.	A variety of Domains Sakel originally imported from Egypt.
S.P.20.	A strain imported from Uganda.
Stoneville (Congo).	An American variety introduced from the Belgian Congo.
Tanguis.	A <i>barbadense</i> type imported from Peru.
Wilds No. 11.	American long staple grown commercially at Zeidab. Large balled early.
X.1530.	A bushy variety selected by A. R. Lambert from Sakel.
X.1530A.	A successor type to X.1530.
X.1530 Hairy.	A hairy selection found in X.1530 by H. E. King.
X.1730.	A bushy variety selected by A. R. Lambert from Sakel.
X.1730A.	The successor type to X.1730 at present grown commercially.
X.1730K.	A reselection of X.1730A type.
XAG.	X.1730 Gash grown.
XAT.	X.1730 Tokar grown.
XL.	Same as BAR.1730L.
PSS.	Pump Scheme Strain.
836, 840, 841,	} Selections from BAR.SP.84 made by Rose.
853, 857, 861,	
862, 891.	
Genes.	
B ₁ .	A dominant weak blackarm resistant factor from Uganda B.31.
B ₂ .	A dominant strong blackarm resistant factor from Uganda B.31.
B ₃ .	A strong partially dominant blackarm resistant factor from <i>punctatum</i> .
B ₄ .	A strong partially dominant blackarm resistant factor from <i>arboresum</i> .
H ₁ .	A hairiness gene from Tanguis and MU.8b.
H ₂ .	A hairiness gene from <i>tomentosum</i> .
H ₃ .	A hairiness gene from Upland (Kapas Pura).

TANGANYIKA TERRITORY.

LAKE PROVINCE.

PROGRESS REPORT FOR THE SEASON 1949-50

BY

J. E. PEAT and J. M. MUNRO.

COTTON, UKIRIGURU.

Planting	...	...	...	...	28th November to 18th January.
Picking	...	...	...	...	May to September.
Legal Uprooting Date	...	...	...	...	14th September.
Rainfall for the Period	1st	October	...	...	...
to 30th June	...	...	...	...	28.97 inches (30.63 inches at Lubaga).

Meteorology.

In spite of a fairly late start, the rainfall distribution was good, with over 5 inches in each of the months December and January, and no severe dry spells during the growing season. After earlier dry planting, the main planting started with the first good rain on December 8th. The season was short and the last heavy rain fell on April 19th.

Staff.

Mr. J. E. Peat was on leave from the end of June until early November, 1950.

Mr. J. M. Munro returned from leave at the end of January, 1950, but unfortunately had to proceed on medical leave from March until June, 1950.

Mr. P. Long, Agricultural Assistant, who went on leave in May, 1950, is not returning to Tanganyika. His services at Ukiriguru were greatly appreciated. He has been succeeded by Mr. D. C. Randall.

Mr. J. Colston, Agricultural Assistant, was succeeded at Lubaga by Mr. G. H. McGavin.

Development.

The building programme of the Public Works Department is nearing completion. This comprises the laboratory-office block, the new ginnery, the labour quarters and the stores.

On Ukiriguru a Farmall MDV. cane tractor with a disc bedder has been at work breaking down, levelling and reridging the standard 5 ft. ridges on the light lands. It has been doing very reasonable work at an inclusive cost of about 30s. an acre for the complete operation. A MV2 cane plough for ridge breaking and remaking is awaited.

At the end of the year labour was very scarce and it would have been quite impossible even to attempt to ridge, by hand-hoe labour, the area required for cotton planting. The Station is still dependent

on casual labour from the area around, as no adequate permanent labour force can be housed at Ukiriguru until the labour lines are complete.

GENERAL INTRODUCTION.

Cotton Crops

The cotton crop for the season has amounted to not far short of 40,000 bales. In the circumstances this must be considered reasonable. As forecast in the 1948-49 report, following the serious food shortages, with the coming of the 1949 planting rains the emphasis had to be on food. The cotton acreage was in the end large, but much was planted in late January and February, about two months later than is desirable. Furthermore, though broadly speaking maize is not a main food crop in the cotton areas of the Lake Province and is liable to droughting, in 1949 there had been both early plantings and considerable December plantings of maize. On these there was considerable breeding up of American bollworm, which attacked cotton from the end of February, developing seriously from early April. The heavy crop loss on much of the cotton grown in the Province was especially striking on the late-planted cotton. In very many cases, including that of Ukiriguru, only one-third to half a normal crop was reaped. Hence the acreage and the effort on the part of the cultivators represented by the production of nearly 40,000 bales could, in other circumstances, have resulted in a very much larger crop.

In 1950/51 the planting of maize before mid-January has been discouraged.

Lake Province Cotton Committee.

Six more Agricultural Assistants (now a total of seven out of the fourteen approved), and the Secretary, were appointed by the Lake Province Cotton Committee; and the recruiting of four hundred Instructors for this work was started.

Tractors and tractor equipment arrived for two pilot mechanisation schemes. Very valuable information has been obtained from the first months of working. It seems highly likely, that, when more experience has been gained, there will be a very rapid increase in the mechanised preparation of land. The tractor and implements in use on Ukiriguru provide important additional information on a further side of this work; when ridging by tractor is extended into the districts it will undoubtedly be an important factor leading to earlier cotton planting and improved and increased production.

The activities of the Lake Province Cotton Committee can only start to influence efficient husbandry in 1950-51, and indeed it is highly probable that their activities will not begin to have much appreciable influence until the following season or even later.

Seed Multiplication.

In 1949-50, UK.46 covered the Mwanza and Geita districts. It was a bad jassid year and Mz.561 suffered. The jassid resistance of

UK.46 showed up well where it bordered on Mz.561. In the 1950-51 season it covers the whole Province with the exception of Shinyanga district. Because of ginning difficulties, sufficient seed was not available in time to complete the planting of the whole Province with UK.46.

UK.48, superior to UK.46, will cover in 1950-51 the Buchosa zone in the Geita district ; it will be in its third year of multiplication.

1950-51 Cotton Planting.

There has been a certain reluctance to start timely land preparation and cotton planting, although early cotton planting is of the highest importance to good yields. This reluctance is undoubtedly influenced by the good food crop harvest of last year and the good profits made from hedge-row sisal, the production of which during the year amounted to some thousands of tons. It will probably mean a substantially reduced 1951 cotton acreage, and thus a reduced production.

In the October-November report of the Regional Assistant Director of Agriculture, the sum of Shs. 1/60 per kilo was mentioned as about the average price paid for this sisal to the cultivator, compared with a price per pound for Grade A seed cotton of 25 cents last season and 34 cents in 1950-51. Such cotton prices are, of course, very substantially less than could be paid. The hedge-row sisal price is not controlled ; the cotton price is.

Against the background of what is very largely a simple peasantry whose cash needs are as yet not great, it may well be necessary to review the profits obtained from such exploitation of hedge-row sisal against the stimulus to cash crop planting as a regular part of the agricultural pattern.

SUMMARY OF THE MAIN EXPERIMENTAL RESULTS.

Significant residual responses were measured at Ukiriguru in three resting crop trials—the sixth year of cropping for two of the trials, and the fourth year of cropping for the third trial.

In the second year of the cropping cycle in a trial at Ukiriguru comparing continuous land cropping with alternate cycles of resting and cropping, the “tumbledown” fallow plots, which last season were depressed, this season showed significantly the heaviest yields.

At Ukiriguru the results from direct manuring are again very good—up to a doubling of the crop. In a further experiment, significant residual benefits were measured in the sixth indicator crop since the application of organic manure. There were residual responses from phosphate applications.

Sulphate of ammonia, applied before flowering, has given a worthwhile increase at Ukiriguru on poor land. The combination of nitrogen and phosphate in amounts roughly equivalent to the amounts of these nutrients in the organic dressing has given equivalent yields.

Any explanation of the residual benefits from organic manuring is more difficult.

Tied ridges on the Ukiriguru hill land, compared with poorer ridging not tied, showed no increased yield of millet, though earlier in the season the benefit had been apparent. But in one trial an appreciable benefit to cotton resulted, the more when stalk weights were used as the measure. In a second trial there was an increased residual benefit from manuring on the tied plots compared with the non-tied. At Lubaga there were substantial benefits from ridged compared with flat cultivation, but no benefits from the tying.

Not much is known about agronomic treatment of the heavier lands. Ridging and ploughing on the Ukiriguru "mbuga" gave reductions in yield compared with flat cultivation and non-ploughing. Some indication is given of the reduction in crop due to unchecked weed growth.

UK.46 has shown up as a worth-while issue, much superior in jassid resistance to Mz.561, and UK.48 is superior to UK.46. Very satisfactory yield trial figures are given. An issue to be constituted from high yielding strains and known as UK.51 is mooted.

The dominant feature of the year was a heavy attack of American bollworm, causing very serious loss. Jassid was also severe, as was bacterial blight on susceptible material. The severe jassid attack allowed further assessment of resistance. The resistance to bacterial blight showing in strains of "Local" origin is considered insufficient.

GENERAL ACCOUNT OF THE WORK FOR THE SEASON.

HUSBANDRY.

Land Resting.

The four simple resting crop trials at Ukiriguru referred to in earlier reports, two of which are now in their sixth year of cropping and two in their fourth year, were this year planted with cotton as the indicator crop.

TABLE 1.
UKIRIGURU HILL SAND. RESTING CROP TRIALS.

Treatment during three years' resting cycle.	Yield in lb. Seed Cotton per acre—1949-50.			
	Sixth year of cropping.		Fourth year of cropping.	
	Trial 1.	Trial 2.	Trial 3.	
1. Control : Continuous millet, grazed in third year. (Trial 3 not grazed)	276 = 100	— = —	353 = 100	
2. Elephant grass, grazed prior to digging in—third year (Trial 3 grazed each year)	318 = 125	— = —	429 = 121	
3. Bulrush millet, manured 1941-42 at 3 tons per acre F.Y.M., grazed before digging in	277 = 101	319 = 100	— = —	
4. Elephant grass, manured 1941-42 at 3 tons per acre F.Y.M., grazed before digging in	306 = 112	444 = 139	— = —	
5. Bulrush millet, manured 1944-45 at 5 tons per acre F.Y.M., not grazed	361 = 132	— = —	— = —	
6. Elephant grass, manured 1944-45 at 5 tons per acre F.Y.M., not grazed	367 = 134	— = —	— = —	
7. <i>Cynodon</i> sp.—manured 1941-42 at 3 tons per acre F.Y.M., grazed before digging in	— = —	373 = 117	— = —	
8. <i>Hyparrhenia</i> sp.—manured 1941-42 at 3 tons per acre F.Y.M., grazed before digging in	— = —	404 = 127	— = —	
9. Pigeon pea—no manure, grazed before digging in	— = —	— = —	452 = 128	
10. Pigeon pea—manured 1941-42 at 3 tons per acre F.Y.M., grazed before digging in	— = —	364 = 114	— = —	
Sig. Diff. (P = .05)	75 = 21%	79 = 25%	61 = 12%	

These trials are planted with bulrush millet and cotton in alternate years; in the past the millet indicator has shown a residual response to the grass rest in Trial (1), but not the two cotton crops. This year the cotton indicator has responded, six years after the elephant grass was dug in. In Trial (2), where the elephant grass was manured in the year of establishment, the response has been consistent, averaging 40% above control over the six seasons. The *Hyparrhenia* plots have averaged 33%, the *Cynodon* 35%, and the pigeon pea 21%; but for these the responses have been more variable.

The yields of the first two indicator crops in Trial (6) are given in Table 2. The planted fallow (the grasses were *Cenchrus*, *Hyparrhenia*, *Brachiaria*, *Bothriochloa*, *Panicum*, and *Setaria* spp.) has given a substantial benefit in both years. The "tumbledown" fallow, however, after a reduced yield in the first year, has outyielded all other treatments in the second year. The reasons for this can only be surmised: weed growth was mentioned in last year's report, especially the strong growth of *Tridax repens*. May it be that the poor crop last year was less of a drain on the nutrients in the soil, and the subsequent crop benefited?

TABLE 2.

UKIRIGURU—HILL SAND. TRIAL 6.

Treatments during the three years' resting cycle	First two years of cropping cycle: indicator crop—Cotton.	
	Yields in lb. Seed Cotton per acre.	
	1948-49	1949-50
1945-46 to 1947-48.		
A. Cropped during the resting cycle.		
1. Control: continuous bulrush millet, undersown with food legumes ...	538 = 100	607 = 100
2. Continuous bulrush millet, undersown with food legumes—dressed three tons per acre compost at establishment of experiment 1945-46)	883 = 164	778 = 128
3. Continuous bulrush millet, undersown with food legumes—dressed 300 lb. single superphosphate per acre for the 1948-49 season (previously dressed 400 lb. per acre raw rock phosphate at establishment of experiment, 1945-46)	922 = 171	808 = 133
B. Resting Treatments.		
4. Three years' planted grass fallow, undersown <i>Tephrosia</i> and <i>Crotalaria</i> —grazed	707 = 131 462 = 86	824 = 135 957 = 157
5. Three years' tumbledown fallow grazed		
Sig. Diff. (P = .05)	100 = 19%	118 = 19%

Similar residual effects from grass rest have been recorded at Lubaga. One trial is now back under grass in a second cycle. A second trial starts a new cycle in 1950-51; the treatments have been modified, and it is hoped to test a grass—legume mixture planted in alternate rows. A new set of resting crop trials was started during the season, to compare the effects of 3, 4, and 5 year grass rests, on flat and tie-ridged plots. The establishment of *Cenchrus* has been markedly better on the flat.

At Ukiriguru, there are two further resting crop trials, established in 1947-48 and 1948-49. The first of these is to stay for five years under resting treatment, and it is proposed to break up the other at the end of 1951.

There can be no doubt that the grazed grass rests have had a beneficial effect. The elephant grass used in the earlier trials is however not really suited to conditions in the Lake Province. Probably the best of the grasses at present worked with is African foxtail (*Cenchrus ciliaris*); Rhodes grass (*Chloris gayana*) can be excellent for a couple of years, especially on better land, but then tends to die out; *Bothriochloa* sp. and *Brachiaria* sp., established from seed, are not really satisfactory. The best grass fallows obtained at Ukiriguru, even under conditions of controlled grazing, are by no means good. At Lubaga on the other hand a pure stand of *Cenchrus* is very impressive compared with the heavily overgrazed natural pastures round about.

Manuring and Fertilisers.

Interest this year again lies in the direct and in the persistent residual effects of organic manures; the importance of phosphates and nitrogen; and what part these two nutrients may play in the organic complex.

Seed cotton yields were affected by the selective action of American bollworm, and in some of the agronomic trials cotton stalk weights have been used as a measure of treatment effects. American bollworm is seldom a very serious pest in the Lake Province; the infestation this year is exceptionally heavy. In a more normal year at Ukiriguru there is a high correlation between cotton stalk weights and yield. Three examples are given from last year:—

								Co-efficient of Correlation (r)				Stalk Weights— Yield.	
								D.F.	Trial	D.F.	Trial	D.F.	Trial
Treatments	...	...	...	...	...	...	...	5	.997	5	.942	4	.974
Error	...	...	...	...	...	...	...	25	.481	35	.686	62	.279
Total	...	...	...	...	...	...	...	35	.908	47	.719	71	.498

To make this account more complete, results from several agronomic trials and observations carried out by the Department of Agriculture Botanist, at Ukiriguru, have been included.

The summary of this season's trials with organic manures (Table 3) shows that in every case they have given a substantial direct increase in yield, followed by residual benefits now lasting up to six years from the time of application. The residual responses to the lighter dressings, 3 tons per acre, are not significant in the sixth year, and the response to a 5 tons per acre dressing appears to have disappeared in the eighth year.

TABLE 3.

UKIRIGURU—HILL SAND

ORGANIC MANURIAL TRIALS—1949-50 SEASON.

Treatment Yields expressed as a Percentage of the Control.

Manure Applied.	1949-50 (Year of application.)			1948-49 (First Residual Response.)			1944-45 (Fifth Residual Response.)		1941-42 (Eighth Residual Response)
	13	V (a)	11 (c)	15	10 (c)	6 (b)	8	1	1
Trial	Cotton	Sorghum	Cotton	Cotton	Cotton	Cotton	Millet	Cotton	Cotton
Control—No Manure	100%	100%	100%	100%	100%	100%	100%	100%	100%
Compost 3 tons/acre	—	—	115 (122)	—	—	128 (146)	107	—	—
F.Y.M. 3 tons/acre	—	—	—	—	—	—	116	—	101 (103)
Compost 5 tons/acre	—	—	—	131 (163)	118 (125)	—	—	—	—
F.Y.M. 5 tons/acre	—	—	—	—	—	—	—	132 (131)	—
Compost 6 tons/acre	172 (145)	195	121 (133)	—	—	—	—	—	—
Compost 7 tons/acre	—	—	—	—	—	—	125	—	—
F.Y.M. 7 tons/acre	—	—	—	—	—	—	142	—	—
Sig. Diff. (P = .05)	38%	41%	13%	19%	11%	19%	23%	21%	25%
Yield of Control (Seed Cotton or Grain in lb./ acre)	377	426	428	449	414	607	685	274	361

Note:—Figures in brackets in all experiments are cotton stalk weights expressed as a percentage of the control—see text.

(a) Government Botanist's Trial.

(b) This trial is manured every third year i.e., 1945/46, 1948/49, 1951/52.

(c) Factorial Experiment—see text, and cf. Table 5.

F.Y.M. made under cover, and compost made in open “bomas” with a higher proportion of straw and crop residues, gave very similar results in the early years of Trial (8), but the former now shows greater residual benefits. In the two factorial trials included in this table, the “main effects,” although equally significant, do not bring out the full magnitude of the increase in yield due to compost (cf. Table 5).

An interesting point has shown up in one trial with tie-ridging; tying there has significantly increased the residual benefit from manure.

TABLE 4.

UKIRIGURU—HILL SAND.

Cotton Stalk Weights—1950.
No Manure. Manured 1948-49.
(Compost 5 tons per acre)

Not tied (Control)	100%	128
Tied	92%	150
Sig. Diff. (P = .05)	13%	—

The value of organic manuring in local agriculture is being stressed by the Agriculture Department; and with the increase in the extension staff some progress is being made. The lasting effect of a single application should be a strong inducement to manuring—if it can ever be got across to the African cultivator.

Compost and single superphosphate last year gave very similar responses in Trials (6) and (10); in Trial (6) the phosphate content of the compost treatment was very much lower than that of the superphosphate.

The suggestion was made that phosphate might be the important constituent in compost, and, becoming available gradually from year to year, that it played an appreciable part in the residual benefit. Previous trials with rock phosphate and silicophosphate had given only small responses. But the effects of the latter have tended to

increase rather than decrease—18% above control this year in a factorial trial, from 400 lb. per acre applied in 1947-48.

The picture this year is somewhat different. (Table 5). Trial (6) still shows a higher yield from 300 lb. per acre of single superphosphate than from 3 tons of compost, with the superphosphate representing the higher phosphate application; but results from Trial 10, and the three new trials put down this year, with dressings equivalent on the basis of phosphate content, still leave the major part of the organic responses unexplained. For rather rough comparison, the amount of phosphate has been taken as equivalent in :—

45 lb. triple superphosphate.
100 lb. single superphosphate.
3 tons compost.

TABLE 5.

UKIRIGURU—HILL SAND.

ORGANIC MANURE AND PHOSPHATE.

1949-50 Yields expressed as Percentages.

<i>Trial No.</i>	13 <i>Cotton.</i> 1949-50	* <i>V</i> <i>Sorghum.</i> 1949-50	† 11 <i>Cotton.</i> 1949-50	† 10 <i>Cotton.</i> 1948-49	6 <i>Cotton.</i> 1948-49
<i>Crop</i>					
<i>Manure Applied</i>					
Control	100%	100%	100%	100%	100%
Single supers 100 lb./acre	—	—	—	99 (101)	—
Triple supers 45 lb./acre	—	—	99 (107)	—	—
Compost 3 tons/acre	—	—	115 (122)	—	128 (146)
Compost 5 tons/acre	—	—	—	118 (125)	—
Single supers 200 lb./acre	116 (108)	—	—	103 (103)	—
Triple supers 90 lb./acre	—	149	96 (112)	—	—
Compost 6 tons/acre	172 (145)	195	121 (133)	—	—
Single supers 300 lb./acre	—	—	—	—	133 (160)
Sig. Diff. (P = .05)	38%	41%	13%	11%	19%

NOTE :—Figures in brackets in all experiments are cotton stalk weights expressed as a percentage of the control.

* Government Botanist's Trial

† Factorial trial—cf. Table 6.

Trial (13), and the Botanist's trial with sorghum (V) were intended to compare the usual method of applying compost and phosphate in the drill, with "reinforcing" the compost heap before application. There was little difference between these treatments; the reinforcing with phosphate was carried out only shortly before applying the compost. Earlier incorporation in the compost heap would have been desirable. These trials, on very poor land, are however a striking example of the effect of compost. The mixture of compost and phosphate (half rate of each) gave results intermediate between the two manures by themselves.

In previous years, nitrogen and potash have had little effect; the nitrogen had been applied at the time of planting. Sulphate of ammonia was applied this season in February in Trial (11), shortly before flowering started; the results are given in Table 6.

This trial was designed with 4 replications, but an unexpectedly heavy storm just after the application of the organic and phosphate treatments, before the ridges were built up, resulted in surface wash between plots, affecting two of the replications so seriously that they had to be discarded.

UKIRIGURU—HILL SAND.

TABLE 6.

TRIAL II.—WEIGHT OF COTTON STALKS PER PLOT IN LB.

Factor.	Alone.	Third Factor at zero. Average over 3 levels of			"Main Effect" averaged over all treatments.	
		N	P	D		
n0	67	—	99	120	130	% 100
n1	108	—	139	143	152	116
n2	136	—	136	151	159	122
p0	67	104	—	120	138	100
p1	118	130	—	134	148	107
p2	111	139	—	136	155	112
d0	67	104	99	—	124	100
d1	134	151	134	—	151	122
d2	160	159	158	—	165	133
Sig. Diff. (P = .05)	45	26	26	26	15	11

MANURE APPLIED 1949-50.

Level	N		P		D	
	Sulphate of ammonia.		Triple supers.		Compost.	
1	125 lb./acre	...	45 lb./acre	...	3 tons/acre.	...
2	250 lb./acre	...	90 lb./acre	...	6 tons/acre.	...

The first point to note is the big increase in plant weight from nitrogen; secondly, that nitrogen this year applied in February, on very exhausted land, was as important a factor as phosphate; and thirdly, that the correct combination of the two can give, in the year of application, results about equal to those of compost. These results are not reflected in the seed cotton yields; this is attributed to the loss of crop caused by the American bollworm attack.

The problem of explaining satisfactorily the residual effects of organic manuring at Ukiriguru remains. While phosphate can be expected to be liberated in the soil over a period of years, it seems unlikely that organic nitrogen can remain effective in these soils for so long.

It is probable that all these results, and possibly the land resting results, are influenced by a seasonal build-up of nitrogen in the soil—as reported from Kawanda by Griffith and Manning—probably varying from year to year with the distribution of the rain. A follow-up of such determinations from Ukiriguru would be very valuable.

Residual effects, of the same order as those from organic manures, have been noted from a very heavy dressing of cotton seed ash; the yield from this treatment, in the sixth year after application, is equal to that from 7 tons per acre of compost; but in January–February these ash plots were outstandingly better than any other treatment (Trial 8, Table 3). The crop was bulrush millet: differences were largely evened out before harvest.

The soaking of cotton seed in nutrient solutions before planting had little effect, certainly nothing of the order reported from experiments in India. There is an indication that a dry dressing with superphosphate might be of some value; this will be followed up when time permits.

LAND TREATMENT.

Ridging and Tying.—The effects of tie-ridging on the Ukiriguru hill sands have not shown up quite so strikingly this year (with a well distributed rainfall) as in some years; but nevertheless, in the main the benefits to cotton are very well worth while. In one trial, now in its fourth year, not manured—well made tied ridges against poor ridges not tied—the yields were 435 lb. and 387 lb. of seed cotton per acre, an increase of 22% (stalk weights 59%). The millet yield was the same in both treatments; early in the season growth was better on the tie-ridged plots, but this difference evened out before harvest.

The further trial laid down last year gave no significant differences in seed cotton or stalk weights as a result of better ridging or tying; the effects of tying on the manured plots in this trial have already been referred to—Table 4.

Ridging the two Lubaga soil types ("ibushi" and "ibambasi") has increased the yield in three of the trials running there, while in a fourth trial there is little difference. On the "ibambasi" the increase was more than 100%. There was no difference in yield between different sizes of ridges (3, 4 and 5 feet), nor between tied and not tied.

On the other hand ridging on the Ukiriguru "mbuga" has resulted in a significant depression in yield of cotton and grain (Table 7). The African cultivator plants his crop on the flat on such soils.

TABLE 7.

"MBUGA."

Yields in lb. Seed Cotton or Grain per acre.

Crop.	Trial 17		Trial IX*		
	Cotton.	Sorghum.	Sorghum.	Sorghum.	Sorghum.
Flat	139	707	555	1165	1135
Ridged†	75	475	530	780	850
Sig. Diff. (P = .05)	54	51	N.S.	310	280

* Botanist's Trial: a trial with 3 varieties of sorghum.

† 3 foot ridges—not tied on "mbuga" soil.

NOTE:—The cotton was late planted and lost crop heavily from American bollworm attack; early in the season the flat was markedly the better grown.

Ploughing.—The whole question of land treatment, especially the treatment of the heavier lands, has become important as a result of the introduction of mechanical cultivation; investigation is very much needed. Ploughing of "mbuga" (valley bottom) soils—perhaps more especially "mbuga" that has been cropped for a number of years, such as at Ukiriguru—may well be largely a matter of weed control, and if this is satisfactory, additional cultivation can apparently reduce yield. In preliminary observations by the Botanist this season,

ploughing of the Ukiriguru "mbuga" compared with a light hoeing, resulted in about a 20% drop in grain yield. On the other hand, weed growth on these soils can be extremely heavy, and they cannot be worked during wet weather when weed growth is at a maximum.

Further preliminary trials, discussed with the Regional Assistant Director of Agriculture, Lake Province, will be attempted this coming season; there will be further evidence from contrasting treatments in at least the one mechanised area in the Kwimba district.

Weed Control.—The importance of weed control is shown in Tables 8 and 9. These are preliminary trials and they will be followed up in the coming season. The differences are large. *Tridax repens* is the most troublesome weed on the hill sand soils.

TABLE 8.

UKIRIGURU—HILL SAND—TRIAL 20—COTTON.

	Treatment.	Weeding Dates.	Yield in lb. Seed Cotton per acre.*	
1.	Early weeding and then normal weeding	21st January, 2nd February, 1st March, 24th March	260	146%
2.	Early weeding only	21st January	68	38
3.	Normal weeding	2nd February, 1st March, 26th March	178	100%
4.	Normal weeding, leaving <i>Tridax</i>	2nd February, 1st March, 26th March	102	57
5.	Late weeding only	1st March, 26th March	75	42
6.	Late weeding, leaving <i>Tridax</i>	1st March, 26th March... ..	42	23
Sig. Diff. (P = .05)			29	16%

* These yields are exceptionally low, due to American bollworm, bacterial blight, and jassid damage on the cotton strain used.

TABLE 9.

UKIRIGURU—"MBUGA"—TRIAL IV—DOBBS SORGHUM.*

	Treatment.	Weeding Dates.	Yield in lb. Grain per acre.	
	Early weeded twice	29th December, 27th February	2250	104%
	Early weeded three times	29th December, 3rd February, 1st March... ..	2170	100%
	Late weeded once	3rd February	1015	47
	Late weeded twice	3rd February, 1st March	1225	57
Sig. Diff. (P = .05)			370	17%

* Botanist's Trial.

Ridge Splitting.—Weed control probably plays an important part in the yields from ridging as compared with flat cultivation. Poorly made ridges, and ridges used a second season without splitting in the usual way, show increased weed growth. The yield of millet from unsplit ridges was 12% less than that of split ridges, and cotton stalk weights were 24% less. The cultivator always splits and rebuilds his ridges before planting—even if sometimes indifferently.

Rotation.—The first results from a rotation trial started last year show that bulrush millet following a cotton crop has yielded 14% (significant) more than millet following millet. A duplicate of this trial has been put down at Lubaga this year, testing cotton and grain in simple rotations against continuous cropping of each.

COTTON BREEDING.

As has already been mentioned, the dominant feature of the season was the heavy American bollworm attack, from fairly early in March onwards, developing seriously in April, into May. In the "mbuga" (valley-bottom) trials, probably somewhere about two-thirds of the possible crop was lost; on the hill trials less, but probably at least half. It was at the same time a year of heavy jassid attack. The strain behaviour, and therefore the trial results, have to be viewed in the light of this insect damage. It was unfortunate that in a year of heavy jassid attack (highly valuable in the sorting it allows in the breeding work) the middle and top crops of the jassid resistant strains were taken by American bollworm. For the jassid susceptible material there was no top crop to lose.

At Lubaga the American bollworm attack was light, but there was also appreciable jassid damage. Thus the relative yielding of the strains at Lubaga make an interesting comparison with Ukiriguru yields.

The cotton breeding results for the season, as shown in strain trial yields and the spinning test results, are very interesting and satisfactory. Good yield improvements over Mz.561 are shown in the trials. There is probably, in the Ukiriguru strain trial results, a greater value from early maturity, and a free-bolling habit, than would show in a year without serious American bollworm. But these are both safe characters.

UK.46 has shown up as a worth-while issue, much superior in jassid resistance to Mz.561. It gins out somewhere about 1.5% better than Mz.561. The ginning percentages shown in Tables 10 and 12 are optimum through a small gin.

TABLE 10.

Mz.561. UK.46. UK.48—1950 SEASON.

YIELD RESULTS—1950 Strain Trials.

	Ukiriguru Hill Trial.			Ukiriguru "Mbuga" Trial.			Ukiriguru (Nyashimba) Trial. (Poor soil conditions)			Lubaga "Ibushi" Trial.		
	Yield Seed Cotton lb. per acre.	Ginning %	Lint % of Mz.561.	Yield Seed Cotton lb. per acre.	Ginning %	Lint % of Mz.561.	Yield Seed Cotton lb. per acre.	Ginning %	Lint % of Mz.561.	Yield Seed Cotton lb. per acre.	Ginning %	Lint % of Mz.561.
Mz.561 ...	601	32.4	100	365	32.0	100	319	32.0	100	630	31.7	100
UK.46 ...	651	34.0	113	370	34.0	108	468	34.6	159	742	33.6	125
UK.48 ...	714	35.0	128	400	33.9	115	537	34.5	181	897	34.1	153
A.2106* ...	—	—	—	—	—	—	348	35.2	120	—	—	—
A.5851* ...	—	—	—	—	—	—	417	34.7	142	—	—	—
Sig. Diff. (P = .05)	92	—	17	77	—	22	119	—	40	146	—	26

* ex Barberton.

TABLE 11.

B.C.I.R.A. SPINNING RESULTS.

Small Scale Spinning Tests (B.C.I.R.A.): replicated material from trials 1949 and 1950.

			1949 <i>Ukiriguru Hill Trial.</i>		1949 <i>Shinyanga Trials.</i>		1949 <i>Trials Ukerewe and Usinxu.</i>		1950 <i>Ukiriguru Hill Trial.</i>	
			<i>Corrected lea count × strength product.</i>	<i>Yarn appearance.</i>	<i>Corrected lea count × strength product.</i>	<i>Yarn appearance.</i>	<i>Corrected lea count × strength product.</i>	<i>Yarn appearance.</i>	<i>Corrected lea count × strength product.</i>	<i>Yarn appearance.</i>
Mz. 561	...	1889	F.G.	2029	F.G.	1846	F.G.	1800	F.G.	—
U.K. 46	...	1876	F.G.	2070	Fair	1806	F.G.	—	—	—
UK. 48	...	1867	F.G.	1995	F.G.	1873	Fair	1840	F.G.	—
A.2106	...	1657	Fair	1664	Poor	1810	Fair	—	—	—
MUSA	...	1812	Fair	1829	Fair	1781	Fair	—	—	—

UK.48 is distinctly better yielding than UK.46, and has much the same ginning percentage.

From spinning reports, for which we are indebted to the Shirley Institute, though no improvement on Mz.561 can be expected, except perhaps in more uniform quality, there should be little change in spinning quality from the substitution of UK.46 for Mz.561, or, later, UK.48 for UK.46.

TABLE 12.

YIELD RESULTS—1950 STRAIN TRIALS.

	<i>Ukiriguru Hill Trial.</i>			<i>Ukiriguru "Mbuga" Trial.</i>			<i>Ukiriguru (Nyashimba) Hill Trial. (Poor soil conditions).</i>			<i>Lubaga "Ibushi" Trial.</i>		
	<i>Yield Seed Cotton lb. per acre.</i>	<i>Ginning %</i>	<i>Lint % of Mz.561.</i>	<i>Yield Seed Cotton lb. per acre.</i>	<i>Ginning %</i>	<i>Lint % of Mz.561.</i>	<i>Yield Seed Cotton lb. per acre.</i>	<i>Ginning %</i>	<i>Lint % of Mz.561.</i>	<i>Yield Seed Cotton lb. per acre.</i>	<i>Ginning %</i>	<i>Lint % of Mz.561.</i>
Mz. 561 ...	601	32.4	100	365	32.0	100	319	32.0	100	630	31.7	100
ex 5/57.	...	...	...	...	...	...	...	...	...	...	...	...
7/7 ...	654	36.4	122	385	35.0	115	392	34.8	133	865	35.7	153
ex 6/318.	...	...	...	...	...	...	...	...	...	...	...	...
7/251	853	34.0	149	465	32.0	127	—	—	—	1031	33.0	171
7/254	794	34.4	140	465	34.0	135	—	—	—	845	33.9	143
ex 6/320.	...	...	...	...	...	...	...	...	...	...	...	...
8/290	—	—	—	—	—	—	613	34.2	206	—	—	—
8/291	—	—	—	—	—	—	504	36.0	177	—	—	—
ex 6/322.	...	...	...	...	...	...	...	...	...	...	...	...
7/287	899	34.3	158	535	34.0	155	—	—	—	935	32.3	151
8/333	—	—	—	—	—	—	424	35.8	149	—	—	—
ex 4/86.	...	...	...	...	...	...	...	...	...	...	...	...
7/314	775	36.4	144	480	35.2	144	—	—	—	965	35.4	171
ex 3/28.	...	...	...	...	...	...	...	...	...	...	...	...
7/139	—	—	—	—	—	—	522	33.0	169	—	—	—
7/141	—	—	—	—	—	—	598	34.5	202	—	—	—
7/142	—	—	—	—	—	—	591	34.8	202	—	—	—
ex L4/112.	...	...	...	...	...	...	...	...	...	...	...	...
7/367	798	33.3	136	445	33.0	126	406	32.1	127	906	34.4	156
Sig. Diff. (P = .05)	92	—	17	77	—	22	119	—	40	146	—	26

In Table 12 are given yield trial results from some of the best of the newer strains developed since the issue of UK.48. Those included are all at least average or better for jassid resistance in the resistance classification. Strains showing less than such average resistance are discarded; in so far as we have gone they are at least average for resistance to bacterial blight.

From what is known of their lint and spinning qualities they seem likely to be acceptable. There are no reports as yet for the 3/28 material. Spinning reports on the 1950 lint are needed.

The 6/318 lots, fairly early and free fruiting, would be expected to show up well in such a season. 6/320 and 6/322 are cousin strains to 6/318. 5/57 and 6/318 were constituents of UK.48. The other two constituents of this issue, 6/29 and 6/44, have shown up as less satisfactory, 6/44 especially showing field and spinning defects. 4/86 was a component of UK.46.

It is hoped that UK.51 will be issued for multiplication at the end of this 1950-51 season. It will be from such material as shown in Table 12 that it will be constituted.

A heavy winnowing of material was possible during the season. For 1950-51, some 680 lots are being grown, not counting introduced lots; 130 are in the Ukiriguru trials, and many are also in the Lubaga and District trials.

Crossing is now to be started within this Ukiriguru material, to combine the outstanding qualities of the different lots. Further, crossing with "Albar," the most valuable bacterial blight resistant stock obtained from Dr. J. B. Hutchinson at Namulonge, will also be undertaken.

The Central American lots from Dr. J. B. Hutchinson, suffering from both jassid and bacterial blight, and rather late planted, were very unhappy indeed. Little seed was recovered from them.

PESTS AND DISEASES.

Jassid (Empoasca spp.).—In the susceptible "Local" strips in the strain trials at Ukiriguru and Lubaga, and in susceptible material elsewhere, there was heavy jassid damage. As already mentioned it is unfortunate that, at Ukiriguru, the heavy American bollworm damage masked yield differences that should have shown up between susceptible and resistant lots. In the strain trials, the jassid bombardment from strips of susceptible "Local" between replications gave a severe test to the material. There has been considerable discarding for insufficient resistance. UK.46 under bombardment showed signs of cracking, but in general cultivation in the districts it showed up markedly better than Mz.561; and had it not been for the American bollworm damage this should have been reflected more distinctly in the yields. The contrast between the resistance of UK.46 and the susceptibility of Mz.561, where their zones joined, was impressive. UK.48 showed up as distinctly more resistant than UK.46.

American bollworm (Heliothis armigera).—The very heavy damage by American bollworm has already been mentioned. The general circumstances of the loss appear to be that much of the cotton in the Province was exceptionally late planted. Because of serious food shortages some maize was planted at the earliest opportunity; there was then a considerable general planting of maize in early-mid December. Egg-laying on this maize took place in the second half of February, together with some egg-laying on cotton. The main egg-

laying on cotton, however, developed early in April, and there was continuous loss of buds, squares, and bolls in April and into May.

In the 1950-51 season the planting of maize before mid-January has been discouraged.

Stainers (*Dysdercus* spp.).—Stainer damage at Ukiriguru was about average. The percentage of Grade C seed cotton was 10%–20%. In the Lake Shore District Plots the percentage of Grade C was much as usual, in general about 5%. In the Maswa District Plots the percentage was about 33%. In Kwimba district there were reports of heavier staining than usual. The percentage of Grade C from District Plots there was about 50%.

At Lubaga the proportion of Grade C was about 50%, in spite of a routine poison application at the end of May. This was too late. The stainer poisoning experiments at Lubaga gave no worthwhile information, and if possible they are to be continued.

Aphis and Lygus.—Both these pests were unimportant.

Bacterial blight (*Xanthomonas malvacearum*).—This past season a fair amount of work was done on bacterial blight on the Ukiriguru strains. Quite heavy loss was caused at Ukiriguru, and in the districts, especially on susceptible material growing poorly on poor land. All the main Ukiriguru strains were grown in a special block, and were sprayed three times with suspension; as were the 1949 single plant selections in the selfing section. Records of attack were kept; and the lots were graded for degree of attack. Results are confused. Even BAR 7/8, B₂ B₃, showed large angular leaf spots, and a percentage of the plants (14%) showed, at one time or another, stem lesions.

The general conclusions reached were as follows: Under the conditions of the year at Ukiriguru fully susceptible lots could be picked out and discarded. The resistance of the B₂ B₂ lots was entirely insufficient against a bad attack. There may be differences in resistance within B₂ B₂ material, but at this stage of the work they are probably not worth much following up. Even the B₂ B₃ strain, though the best of the material graded, showed stem lesions.

The main approach now must be, through a hybridizing programme, the introduction of resistance from "Albar."

Acknowledgments.

It is a pleasure to record the co-operative working with Mr. H. Doggett, Botanist, Department of Agriculture, who is developing the food crop work from Ukiriguru.

There is at all times close contact with Mr. N. V. Rounce, Regional Assistant Director of Agriculture, and his Provincial staff, on the extension of Ukiriguru findings, and the multiplication of seed stocks in the Province. Ukiriguru derives reciprocal benefit from being in touch with the problems of the field and the difficulties of application.

PROGRAMME FOR 1950-51.

The general approach remains as in the past few years—a continuation of the cotton breeding programme, and as much agronomic investigation of importance to the cotton growing areas as can reasonably be attempted.

The main addition to the cotton breeding work will be the start of a hybridizing programme, crossing within the Ukiriguru known strains, and crossing with "Albar," the bacterial blight resistant strain of Allen.

The manurial and fertiliser trials and the resting and agronomic trials continue. A further trial, on weeding effects on cotton, has been added.

Some simple preliminary experiments on "mbuga" treatment are to be attempted, as the present scanty labour force permits, to provide much needed information for the tractor and extension work in the Province.

The cotton selection and testing, still a large part of the work of the Station, continue as before.

The extension work at Lubaga and in the District Plots continues.

APPENDIX.

ORIGIN AND SPECIAL CHARACTERISTICS OF THE MAIN COTTON STRAINS MENTIONED:

- LAKE PROVINCE "LOCAL." The commercial cotton of the Province prior to the issue of Mz.561—mainly of Uganda Local Origin.
- Mz. 561. A straight selection from "Local," first multiplied in season 1939-40; the seed stock now being replaced by UK.46.
- UK.46. A seed issue with fair jassid resistance, first multiplied in the 1946-47 season; made up of the four best Ukiriguru strains and the three best Lubaga strains, available at that time.
- UK.48. A seed issue made up of four strains, 5/57, 6/29, 6/44, and 6/318, of better jassid resistance than UK.46, and with some blackarm resistance; first issued for the 1948-49 season.
- 5/57. A derivative of 3/17, itself a straight selection from "Local."
- 6/29. ex 2/388, itself a derivative of Mz.561.
- 6/44. A derivative of 3/17, itself a straight selection from "Local."
- 6/318. ex 4/35, itself a derivative of Mz.561.
- 3/28. Direct out of Mz.561.
- 4/86. ex 1/45, ex Mz.561; a constituent of UK.46.
- 6/320, } ex 4/35, itself a derivative of Mz.561; cousin strains to 6/318.
- 6/322. }
- L4/112. A Lubaga strain, ex Mz.457.
- A.2106. A Barberton strain, U4 × Cambodia; now the standard strain in cultivation in the Barberton district.
- A.5851. ex Barberton; MU8A × BP.52²; a promising parent at Barberton.
- MU8A. A Malwa Upland strain selected by Dr. J. B. Hutchinson; the seed was obtained from Barberton.
- "Albar." A general term for a group of selections from Allen, highly resistant to bacterial blight: ex Dr. J. B. Hutchinson.

EASTERN PROVINCE.

PROGRESS REPORT FOR THE SEASON 1949.

BY

A. G. BEBBINGTON and H. J. de S. DISNEY.

Planting period	...	...	...	Mid-February to mid-April.
Picking	...	...	...	August to October.
Uprooting	...	...	...	By 31st October.

INTRODUCTION.

The report covers the work on Ilonga station and on five district plots. One further plot was abandoned as the land was required by the owner.

Mr. Bebbington proceeded on leave at the beginning of October.

Building on Ilonga continued during the year but was very slow owing to the short supply of materials.

By the end of the year, however, all the European staff were provided with quarters of various types. Labour lines to accommodate one hundred labourers were completed. An ample water supply from the Ilonga river was laid on to all necessary points, and stores and workshops were built.

COMMERCIAL COTTON CROP.

The production was the highest for the Province since 1941, owing to increased acreage on account of the higher price. The grade of the crop was high owing to the very small incidence of insect pests.

WEATHER.

The season was very poor, no more than eight inches of rain being registered on Ilonga during the growing season. This resulted in the loss of many maize crops and a state of partial famine in the Province. Fortunately, in spite of the low total at Ilonga, the rainfall was distributed in such a way as to allow the production of a reasonable maize crop. The cotton crop, however, suffered owing to late planting, no cotton being planted on the station before the end of March.

COTTON BREEDING.

Strain trials were laid down at Ilonga and on four district plots. The results of these were disappointing as the yield figures from plot to plot were conflicting and also did not agree with figures for previous years. This means further delay in the production of an improved type, which is so much needed for the Eastern Province. Two of the new bulks showed promise but further testing will be necessary before any decision can be made as to their merits.

The single plant work was continued but could not be carried out in full detail owing to the departure on leave of the senior author.

INSECT PESTS.

The usual routine recording of the incidence of insect pests and plant development was carried out at Ilonga and on all district plots. With the arrival of Mr. Disney this work has now been extended to include a study of wild host plant relations. Particular attention was devoted to American bollworm (*Heliothis armigera*) and its occurrence on cultivated crops.

Insect pest populations were generally low. The proportion of Grade I picked was high, being of the order of 70% of the crop.

American bollworm (Heliothis armigera).—This was present in only small numbers over the whole Province, which may have been due to the failure of the majority of the maize crops. One Indian plantation showed a heavy attack, but this could be correlated with continuous maize plantings and the fact that maize was interplanted with cotton.

American bollworm has now been found in small numbers throughout the year on out of season maize planted beside permanent streams.

Pink bollworm (Platyedra gossypiella).—A certain amount of damage was caused to the late crop by this pest. In the Rufiji valley, however, both the rain-grown and flood land cotton were suffering serious damage when seen in August. This is undoubtedly due to the fact that the two types of cultivation of the crop, when grown side by side, tend to increase populations of this pest.

Spiny bollworm (Earias spp.).—No populations of any real importance were recorded.

Stainers (Dysdercus spp.).—The usual four species, *D. intermedius*, *D. fasciatus*, *D. cardinalis* and *D. nigrofasciatus*, were present. Only in two of the district plots were serious numbers recorded. In these two cases the percentage of Grade I dropped to 54% and 46%. The peak populations were 2,000 and 2,700 per acre respectively. This damage was caused, in the main, by mixed populations of *D. intermedius* and *D. fasciatus*.

In the Rufiji valley serious damage to the flood-grown cotton crop was seen. This would appear to have been caused by stainers bred on the rain-grown cotton.

D. superstitiosus was recorded breeding on *Hibiscus* spp. from the beginning of the year until April. It was not found in the cotton crop.

Helopeltis spp.—This was only recorded as doing a certain amount of damage in two isolated cases.

Jassid.—This pest was present in the usual small numbers.

Lygus spp.—The incidence of this pest was of no importance.

Red bollworm (Diparopsis spp.).—Six larvae, supposedly of this genus, were collected in the Southern Province on *Gossypioides kirkii*

in 1948 but only one moth emerged, on 5th September, 1949, giving a pupation period of thirteen months. The one adult was sent to the British Museum for identification. It was reported as *Diparopsis* sp. but "almost certainly not *castanea*." Further specimens will be sent when available.

A further search for Red bollworm in the Rufiji valley was made by the authors in August without result.

INSECTICIDE TRIALS.

Two of these trials were carried out, one on Ilonga and another on a neighbouring estate.

The Ilonga trial was conducted with a mixture containing 4% DDT and 0.5% γ benzene hexachloride. The treatments were two, four and six applications at fortnightly intervals, at a rate of approximately 16 lb. per acre. A randomised block layout with a control and six replications was used.

It was planted late owing to lack of rain and the growth of the plants was not good. All squares on 60 plants of each treatment were ticketed with the date of setting and records were kept of shedding and final damage to bolls.

Owing largely to the fact that populations of both American bollworm and stainer were low, no definite results were obtained.

The following points may, however, be noted :—

- (i) The dust did decrease the amount of shedding due to bollworm.
- (ii) All the treated plots showed much more shedding from undefined causes than did the control plots. An extremely severe attack of *Aphis* developed during June. It is thought that the dust killed off the predators which normally exercise a large measure of control of *Aphis*, and the consequent *Aphis* outbreak was the cause of increased shedding. This is supported by the fact that two control plots with two sides free from contact with dust gave the highest yields.

This killing of predators and increase in *Aphis* has been found in America (Ref. Newsom, L. D., and Smith C. E., *Journal Econ. Ent.* 42, 6 December, 1949, 904).

The final yield figures showed no significant difference but the yields of the control plots in the second picking were significantly better than the treated plots.

The second trial was carried out over twenty acres. Two types of dust were used : 5% DDT and 4% DDT with a 0.5% content of γ benzene hexachloride. There were eight replications and the dust was applied three times at fourteen day intervals.

No significant results were obtained presumably because of the low incidence of insect pests.

GENERAL INSECT WORK.

This may be divided into two sections. Firstly, the search for the wild and cultivated hosts of American bollworm and the point in time and extent of its occurrence on them. With this is coupled the working out of its life history at different times of the year. Results so far show that, as was expected, the host situation is very complex. Good progress was made in listing the various hosts. Pupation work was held up owing to lack of facilities.

Secondly, the investigation of the wild host relationships of the four *Dysdercus* species which occur in cotton. A number of tree hosts, perennials and annuals have been listed and routine recording established.

Both these schemes entail a good deal of search work, very often in thick bush, and consequently progress was slow. This was further hampered by the necessity for training extra African recorders.

SUMMARY.

1. The season was one of very poor rainfall and most maize crops failed. The cotton crops on Ilonga were poor.
2. Conflicting results were obtained from the strain trials although two bulks showed some promise.
3. Two insecticide trials gave no significant results from a yield point of view.
4. A start was made in the identification of the wild and cultivated hosts of the principal pests of cotton.

PROGRAMME FOR 1950.

The testing of strains and selection work will be continued.

An insecticide trial, with stronger mixtures of DDT and Gammexane and including Toxaphene, will be carried out on Ilonga.

The investigations into the host-plant relationships of American bollworm and stainer will be carried on.

NYASALAND.

SEASON 1949-50.

COTTON EXPERIMENT STATION

BY

H. C. DUCKER, W. L. MILLER AND S. H. EVELYN.

H. C. Ducker went on long leave in September, 1949, returning to the Station at the end of March. Mr. M. S. Hastie was transferred to Uganda in June, 1950.

<i>District.</i>	<i>Elevation feet a.s.l.</i>	<i>Types of Crop.</i>	<i>Months in which :</i>		<i>Legal Close Season.</i>
			<i>Sown.</i>	<i>Harvested.</i>	
Lower River... ..	200—500	{ Semi-summer Winter	Jan.-Feb. Mar.-Apr.	July-Oct. Sept.-Oct.	} Nov.-Dec.
Central Areas, Southern and Central Provinces	1,000-2,500	Summer	Dec.-Jan.	June-July	Aug.-Nov.
North Nyasa : Karonga	About 1,600	Winter	Apr.-Jun.	Oct.-Dec.	Jan.-Mar.

It will be noticed that there are some changes in the cropping table given above: Government decided this year to introduce July 31st up-rooting in all Central Areas, a welcome advance in Sudan bollworm control measures ; at Karonga seed issues do not now begin till April 15th and every effort is being made to complete plantings by June 15th. There continues to be no effective control of bollworm in the Lower River, where it seems unlikely that irrigation and winter cropping can be developed for some years yet ; in the interim, Government is finding difficulties in the application of summer cropping. For the Experiment Station in particular, and other parts of the Central Areas in general, the past season has been marked by excessive or even disastrous rains. Cotton production in the Central Areas has suffered and a very small crop was reaped. Karonga benefits from heavy rains, since good floodings occur, and a near record crop is expected. In the Lower River, where latish flowering yields most of the crop, conditions are fairly normal, and there may be good late pickings. The past twenty-four months have been distinguished by the worst drought, the hottest hot weather, the heaviest rains and the coldest cold season, in that order, yet experienced at Domira Bay. While work has suffered from the inclement conditions it seems likely that the cotton strains which have survived will have benefited from the intense natural selection which has occurred. Some useful work has been possible on other crops, and it may be of interest to note that sorghum and groundnuts, usually deemed drought resistant, have done fairly well under water-logged conditions.

MECHANISATION.

Most of the fields for the season's cropping were prepared mechanically, though much hand ridging was necessary. Even this short experience has demonstrated that the implements provided were unsatisfactory for the type of heavy work involved in these soils.

Breakages were frequent and ploughing not deep enough. The early ploughing and harrowing was just good enough to take the place of hand digging. It is obvious that most careful stumping must be carried out to prevent breakages, and this work is being given high priority. In time the work will become easier and less expensive, as operations can then be carried out earlier. This season, because of the continuous and excessive rains, it was impossible to carry out any inter-cultivation or early weeding with mechanical implements.

COTTON.

Selections, Bulks and the Variety Trial at the Station.—Single rows of 149 selections were duplicated in two fields, isolated from each other. As expected, the high cotton stainer infestation in the previous season severely affected germination, and, even though the sowing seed was carefully sorted, a mean germination of only 35% of the seeds sown in the field was obtained. The sowing seed was not treated against blackarm and a very high primary infection resulted.

The replicated breeding experiments, together with the manurial trials conducted by M. S. Hastie, were an almost complete failure as a result of a combination of the abnormally heavy and continuous rains of January, February and March, the very poor and weakly germination of the seed and the very heavy primary blackarm infection. As a mean average yield of only 145 pounds of seed cotton per acre, mostly stained, was obtained, the experiments were abandoned except for the saving of seed stocks.

The Outstation Trials.—Variety trials of nine promising selections and Crown Land Bulk were conducted in randomised blocks at Karonga (Northern Province), Sharpevale (Central Province) and Kalembo, Lisungwe and Makanga (Southern Province). The Makanga and Sharpevale trials failed, and stands were so variable in the Kalembo trial that the results were valueless. At Lisungwe, the trial was well established and the results follow. At Karonga, where cotton is winter-sown in May/June after natural flood-irrigation, reaping occurs too late for results to be included in a current year's report. However, last season's results, which were not available for inclusion in the 1948-49 Report, are given below and demonstrate what cotton can do in Nyasaland in the absence of Red bollworm.

The Lisungwe Trial—1949-50. (Pounds Seed Cotton per Acre.) (Sig. Diff. = 112 lb.)									
(CLB) (Chik)	CL	CL	CL	CL	CL	CL	CL	CL	CL
	6122	7057	7060	6055	7059	7061	7064	7129	7126
[807	723	712	712	712	656	645	628	611	605

The Karonga Trial—1948-49. (Pounds Seed Cotton per Acre.) (Sig. Diff. = 153 lb.)							
CLB. (K'ga)	CLB (C'mo)	CL 6086	MU.8B	CL 6046	CL 6045	CL 6161	CL 6019
1820	1702	1601	1584	1573	1556	1489	1449

Strains enclosed in the same bracket do not differ significantly.
(Chik) = Chikwawa; (K'ga) = Karonga; (C'mo) = Chiromo.

The outstation trials have now been conducted for the past decade with much the same results, namely that the commercial CLB almost invariably outyields the selections at all sites except in the Lower River, where Red bollworm damage flattens out varietal differences to a common level. The fact that CLB repeats its higher yielding performance under conditions as widely different as those of Karonga, this Station, Sharpevale and Lisungwe, suggests that its known high genetic variability confers greater adaptability to a range of conditions than is to be found in its more uniform, inbred progeny. It is thus hoped that a mixture of the best of the present CL selections will overcome this yield advantage and such a mixture will be multiplied next season to obtain seed to try this out. However, should this mixture fail in its purpose, large plots of Karonga and Ngabu Crown Land Bulk will also be grown at the Station and the "filtering" technique, successfully employed in other countries, will be applied to all three.

The Red Bollworm Problem in the Lower River Area.—At the instigation of the Department of Agriculture and with the co-operation of the Portuguese Government, an attempt to reproduce the effect of a non-cotton year in miniature was made last season by prohibiting cotton growing in the area within a five-mile radius of Makanga. This season, systematic counts were recorded, by the Government Entomologist, of Red bollworm incidence in observation cotton plots sited at Makanga and at mile intervals along its North and East radii. Control cotton gardens, bordering the experimental area, were also observed. Red bollworm infestation was early and high at all sites, demonstrating that the moth is capable of a flight range of more than five miles.

A Possible Virus Disease of Malvaceous Plants.—In May, 1949, during a visit to the Ndakwera Village of Chikwawa District, a patch of wild *Sida carpinifolia* was observed by S. H. Evelyn, showing symptoms typical of the cotton leafcurl disease caused by *Gossypium* Virus No. 1. Since then the same disease has been found by S. H. Evelyn at Chikonje and Ngabu and by Mr. Wiehe the Government Mycologist, with whom the first occurrence was discussed, at Bilila.

MISCELLANEOUS CROPS.

A collection was made of food crop varieties, of local origin and from the Sudan, Northern Nigeria, Uganda, Tanganyika, Northern Rhodesia, South Africa and Swaziland. Those which arrived in time were sown on 30th December, 1949, and, notwithstanding the abnormal rainfall, some very useful data were recorded. Of 73 strains of sorghum, 30 gave very high yields, and striking varietal differences were noted in susceptibility to virus, *Gleo-cercospora* and *Giberella* leaf spots, smut and stem borer. The most promising will be tried out at various places next season with the co-operation of the Department of Agriculture. Five local varieties of *Pennisetum* gave high yields, and though very impure, contained material of high selective value. *Pennisetum* is an important crop in the Port Herald area,

where it is grown as a mixture with sorghum. Forty-nine varieties of groundnuts, including two local strains, were grown, and in spite of the abnormal season twenty-seven of them gave excellent yields. Special attention was given to varietal differences in susceptibility to Rosette disease, which often causes severe loss of crop in this country.

ACKNOWLEDGEMENTS.

The co-operation of the Staff of the Agricultural Department is gratefully acknowledged.

PUBLICATIONS.

Evelyn, S. H. (1951). "Sorghum Breeding in the Sudan." World Crops.

PROGRAMME FOR 1950-51.

This will follow much the same lines as in the past, except for the bulking of a mixture of the best CL selections and the "filtering" of this and of bulks of Karonga and Ngabu commercial seed.

[Included by courtesy of the Southern Rhodesia Government.]

SOUTHERN RHODESIA.

COTTON RESEARCH STATION, GATOOMA. PROGRESS REPORT FOR THE SEASON 1949-50.

BY

A. H. McKINSTRY, R. W. JAMES AND L. C. H. LONG.

Planting Period	...	...	...	8th-11th and again 14th-18th November, 1949.
Flowering	...	...	...	Commencing end of January, mainly February and March, 1950.
Picking	...	...	...	May and June, 1950.
Legal Uprooting Date	...	...	...	30th September, 1950.

METEOROLOGY.

The total rainfall for the season was 27.89 inches. The falls were evenly distributed with no very long periods of drought or exceptionally heavy downpours. The first soaking rains fell during the first week of November and, as a result of a dry spell lasting 10 days, operations were mainly completed by the 18th of that month.

The rainfall for the months of December and January was consistently good. February showed a higher total, followed by a considerable drop during March with the longest periods of dry weather between falls. Good rains were recorded for the first week of April, the season ending on the 6th of that month.

The lowest mean maximum and minimum temperatures were recorded during June. Warmer weather was experienced during July, with a further rise in mean maximum and minimum temperatures for August, 1950.

GENETICS AND BREEDING.

U.4 Replicated Progeny Trial.—It was stated in last year's report that the progeny of selections taken from 9L34 and closely related strains had shown no definite improvement on their parents in yield in combination with desirable lint characters (E.C.G.C. Progress Reports 1948-49, p. 113). In order to confirm this statement with adequate experimental evidence, a replicated progeny trial of 64 single plant selections from U.4 material was laid down in an 8 × 8 Lattice Square design with nine replications. The results of this experiment show that none of these progenies is significantly better in yield and other characters than 9L34, the U.4 strain at present in commercial cultivation. This conclusion is further strengthened by the results of the Main Strain Trial.

Main Strain Trial.—This trial of twenty-five strains, which included eighteen U.4 derivatives, three 7C derivatives and four MU.8 $\times$ BP.52² derivatives, was laid down in a 5 $\times$ 5 Lattice Square design with three replications. The analysis of yield of seed cotton and that of lint showed that no U.4 strain was significantly better than 9L34. Seven U.4 strains were significantly better than 9L34 for seed index but none of these strains was significantly better for lint index or for ginning percentage.

The MU.8 $\times$ BP.52² strains, A585I, A6I6, A6I8 and A6I9 from Barberton, although not significantly better than 9L34 for yield of seed cotton or lint, or for seed index, are significantly better for ginning percentage, lint index, and boll weight.

TABLE I.
SUMMARY OF RESULTS OF MAIN STRAIN TRIAL, 1949-50.

	Yield Lint Lb./Acre.	Ginning %	Lint Index, grams.	Boll Weight grams.
Best MU.8 $\times$ BP.52 ² Strain A618	277	36.94	5.69	5.09
Mean of 3 7C Strains	268	36.11	5.16	4.61
Mean of 3 MU.8 $\times$ BP.52 ² Strains	252	36.16	5.54	5.18
9L34	251	33.87	4.81	4.20
Mean of 17 U.4 Strains	208	34.34	5.01	4.29
Sig. diff. P 0.05	69	1.1	0.41	0.40

Analyses of lint quality have not yet been completed, owing to the late arrival of equipment. The indications are, however, that the MU.8 $\times$ BP.52² derivatives will be better than any U.4 or 7C strains.

Single Plant Selections and Modal Bults.—Selections were made from BP.52, A585I, A6I6, A6I8 and A6I9. These selections were based on plant habit, yielding capacity, and lint quality. The selections were analysed for lint index, seed index and mean maximum lint length (Bailey protractor, 5 seeds per plant). Modal bults were then formed for each strain (see Manning, E.C.G.C. Progress Reports, 1947-48; 1948-49). Nineteen selections were made for high lint index and seed index.

Kidney Outcross.—Backcrossing was continued to the U.4 and 7C recurrent parents. A few lines show promise as suitable for mechanical picking. From conversation with Mr. A. N. Prentice it seems probable that the unknown parent of the cross was a U.4 strain U.4/6250.

MU.8A $\times$ BP.52.—As a result of the performance of the MU.8 $\times$ BP.52² strains from Barberton last year, it was decided to repeat the cross and backcross at Gatooma so that selections can be made in earlier generations. The cross was made this season using MU.8A supplied by Dr. J. B. Hutchinson and BP.52 from Barberton. The first backcross will be made in the coming season.

Mechanical Picker Type Selections.—A number of single plants were selected last season for plant habit of the type conceived to be the most adapted to mechanical, spindle-type, picking. A number of

re-selections with short-branch, cluster habit, have been made from the progeny rows grown this season.

Quality Linted Americans.—Twenty quality-linted American strains were imported from various experiment stations in the United States in 1949 in an endeavour to obtain material for quality crosses. These strains were grown at Gatooma this season, but the jassid attack and blackarm damage were so severe that very few flowers were formed and it was, therefore, impossible to make any of the crosses planned.

AGRICULTURE.

Fertiliser trials carried out at this Station in the past have failed to give satisfactory results. In consequence no inorganic fertilisers are applied to the commercial crop. Manuring has been limited to the application of compost when available.

An N.P.K. trial of $3 \times 3 \times 3$ design, with two replications, was carried out on the Station this season. The commercial strain 9L34 was used. The trial was situated on contact soil typical of some of the cotton growing areas in Southern Rhodesia.

The fertiliser was applied at the time of planting, by hand placement, in drills approximately three inches to one side, and two inches below the seed level.

The fertilisers used were :

N.	as Chilean Nitrate of Soda	...	16%N.
P.	as Superphosphate	...	18.5% P_2O_5 .
K.	as French Low Grade Muriate of Potash	...	60% K_2O .

The rates of application were Nil, 250 lb. per acre, and 500 lb. per acre.

Yields of seed cotton in pounds per acre for the main effects and two factor interactions are shown in Table II.

TABLE II.
MAIN EFFECTS AND TWO FACTOR INTERACTIONS TO THE NEAREST POUND OF SEED COTTON PER ACRE.

	P ₀	P ₁	P ₂	
n ₀	413	445	456	438
n ₁	492	497	483	490
n ₂	483	557	509	516
	k ₀	k ₁	k ₂	
n ₀	300	509	506	—
n ₁	318	561	593	—
n ₂	361	514	673	—
	P ₀	P ₁	P ₂	
P ₀	355	463	570	463
P ₁	347	565	587	499
P ₂	278	555	615	483
	326	528	591	481

Standard Errors (Differences).

Main Effects = 17. Two Factor Interactions = 29.

Significant Differences.

	Main Effects.	Two Factor Interactions.
0.05	35	59
P = 0.01	47	81
0.001	63	109

At current fertiliser costs and seed cotton prices the k_1 application returned a profit of about £3 per acre ; p_1k_1 , about £2, and k_2 and n_1k_1 , about £1 10s. od. Other applications were not profitable.

Although some of the results are highly significant, no definite recommendations can be made to farmers, on the use of fertiliser placement for cotton, until further evidence has been accumulated.

This experiment will, therefore, be repeated in the coming season. Another experiment using Sulphate of Ammonia and Sulphate of Potash instead of Nitrate of Soda and Muriate of Potash will also be laid down.

COTTON PESTS.

Although Sudan bollworm was again the most prevalent pest in the important early crop, the loss caused by the insect this season was one of secondary importance to losses due to other factors during the first six weeks of flowering.

Damage caused by American bollworm was light, and losses due to cotton stainers were about normal, only a small percentage of the crop being classified as stained.

Jassid populations were greater than in 1948-49, but less than in 1947-48. On the Station, 9L34 was not visibly affected by the pest except for occasional plants, but there were a few reports of jassid in abundance in growers' crops. One of these came from the Mrewa district, where African cotton growing has expanded recently. Again, observation on two farms showed that cowpeas planted near cotton provided a breeding ground for jassid. These observations strengthen the present policy of breeding for increased jassid resistance in varieties for issue to growers.

In an experiment the yield of cotton was not increased when 1 lb., 3 lb., or 5 lb. per acre of DDT was applied in the form of an emulsion (E.27) at the rate of 25 gallons per acre. The application was made six weeks after the plants had commenced to flower. Rainfall conditions, mainly, prevented an earlier application.

In another experiment the systemic insecticide Pestox III was applied at strengths of 0.33%, 0.50% and 1.00% of the active ingredient, during the progress of a moderately severe aphid attack, and about three weeks after flowering had commenced. Subsequent observation showed that aphid populations were negligible on plants in the treated plots for a period of at least four weeks after the application of the insecticide. The 0.50% and 1.00% treatments had a phytocidal effect on the plants when first applied, but recovery took place later. There were no significant increases in yield due to treatments in this experiment.

MECHANISATION.

Cotton Picker Operations.—What must be regarded as only the first preliminary trials in picking cotton by machine were made with an International Harvester Company high-drum cotton picker. Approximately 25 acres of the variety 9L34 were harvested by this machine. Details of the results and operational costs, and on spinning tests, will be given in a separate report.

It is certain, however, that machine picked cotton is not to be regarded as a substitute for hand picked where labour for this is available. It is obvious that for greatest efficiency the picking of cotton by machine will require the installation of pre-ginning cleaning machinery, the use of defoliants and a cotton plant having a semi-cluster growth habit, together with the organisation which must accompany the operation, servicing, and movement of cotton picker units.

Destruction of Cotton Plants.—In an attempt to mechanise the end-of-season destruction of cotton plants, which is necessary to reduce the carry-over of cotton pests, trials were made with a two-row stalk cutter and a heavy disc harrow.

While the use of these machines, coupled in tandem, effected a saving in the labour normally employed in cutting the plants by hoe, and raking them into windrows for burning, prior to discing the land before ploughing, the actual destruction of the plants left much to be desired.

Nevertheless the combination of cutter and disc harrow does ensure, firstly, that disc harrowing is carried out for the destruction of Sudan bollworm overwintering pupae, and secondly, that the land is prepared for an easier ploughing under of plant residues.

[Included by courtesy of the Government of the Union of South Africa.]

SOUTH AFRICA.

AGRICULTURAL RESEARCH STATION, BARBERTON.

PROGRESS REPORT FOR THE SEASON 1949-1950

BY

A. R. PULLEN.

Planting	...	...	...	...	8th to 19th November, 15th Dec.
Picking	...	...	...	...	April to June.
Legal uprooting date	...	...	...	...	30th September.
Rainfall for year ending June 30th	...	...	...	...	26 inches.
Rainfall from July 1st to February 28th	...	...	...	...	19.8 inches.
Mean maximum temperature for season	...	...	...	...	83.4 deg. F.
Mean minimum temperature for season	...	...	...	...	62.7 deg. F.

ADDITIONAL METEOROLOGICAL INFORMATION.

Rainfall was more than adequate from early November until mid-January. Three heavy rainstorms of short duration, one registering just under $2\frac{1}{2}$ inches in about 40 minutes, occurred during December.

No effective rain fell from 5th January until 31st March. Between these two dates half an inch was recorded once and 0.4 inches on two occasions. From the last day of March until the end of April 4.7 inches of rain fell at the Station ; after this there was little rain.

The humid conditions during December and early January favoured temporary blackarm development in young cotton.

From early January until late in February a succession of strong winds was experienced, causing considerable damage to some crops, especially maize.

Light frosts occurred on 22nd, 23rd and 24th May.

No damaging hail fell on the Station.

TRANSFER OF STATION.

The Research Station and its buildings were handed over to the present Officer in Charge by Mr. MacDonald, representing the Corporation, in October, 1949. The new staff then consisted of the Officer in Charge and a European foreman.

In January, 1950, a technical officer, Dr. J. G. Ossewaarde, was appointed, to work more specifically on fibres for bags and cordage, of which, at the outset, varieties of *Hibiscus cannabinus* would be the most important.

A second technical officer was appointed in February.

It was realised that the programme of work for the first season would have to be limited, the object in the first instance being to maintain some continuity in the cotton breeding programme. The officers of the Corporation very kindly left a big range of cotton seed stocks, representing established varieties and promising material from earlier crosses which should form a fairly adequate basis for breeding work for the immediate future.

THE COTTON CROP.

The revival of interest in cotton production in South Africa has been maintained. Attractive prices (25 to 29 pence per pound of lint) and a requirement at the present time of about 50,000 bales of lint per annum by local spinners have further stimulated production.

The main expansion in cultivation was in Northern Natal and the Lowveld of the Transvaal. Cotton acreage was about trebled, approximately 30,000 acres being planted, but the crop harvested was disappointing. Factors responsible for poor yields generally were, in the Magut and Swaziland areas, mainly attacks of American (*Heliothis* sp.) and Red or Sudan bollworms (*Diparopsis castanea*), and in the Barberton area, drought, American bollworm and "boll rot." In the Pongola area near Magut a severe attack of Spiny bollworm (*Earias insulana*) developed late in the season in irrigated cotton after severe attacks earlier in the season of American and to a lesser extent Sudan bollworm. Crop losses were particularly heavy in Northern Natal.

Attempts at control of insect pests by means of chemical dusts and sprays were not successful. This is attributed to the fact that treatment was not commenced sufficiently early and was not generally repeated at short intervals, and that the method of application was often ineffective.

The severity of insect attack, at a time when attention is being focussed on cotton growing and a big expansion in production is expected, has served to emphasise the need for more information on measures for combating these pests. It is hoped that for the coming season producers, with the assistance of certain commercial interests, will be better prepared to meet any attack. However, up to the present the need for fundamental research on the use of the newer insecticides is not being properly met.

GENERAL PROGRAMME OF WORK.

Because of a shortage of staff, a considerable area of the farm was planted to the Station's Hickory King and "streak" resistant maize. Some breeding for "streak" resistance in maize was commenced. A number of varieties of *Hibiscus cannabinus* and a few of *H. sabdariffa*, collected by the Department of Agriculture, were grown for observation, yield tests, selection and seed multiplication. Bults of the more important progenies of crosses between cotton

varieties were grown for observation and selection. A cotton variety trial was conducted. The material used was suggested by Mr. D. MacDonald of the Corporation's staff. Observations of *Verticillium* wilt incidence and resistance in cotton were made and a number of crosses made between the wilt-resistant B181 and a selection of other varieties.

In co-operation with the Division of Chemical Services samples of cotton plants at two stages of development and some of the soils of the Station were analysed chemically. An experiment to determine the effect of applying muriate of potash to cotton at different times was laid down.

A collection of grasses which might be of use in the future development of the Station, as leys or for soil erosion control, was started. These will be tested out on a bigger scale once the farm lands have been contoured.

DEVELOPMENT OF THE STATION'S CROPS.

The season commenced favourably, with rains sufficiently early to ensure a good seed bed for cotton planted between 8th and 19th November. Germination was good but the early development of cotton was somewhat retarded by cool, cloudy weather experienced during a rainy period. At this stage some angular leaf spot and blackarm (*Xanthomonas malvacearum*) developed but was later checked by the onset of drier conditions.

A severe infestation of American bollworm, concentrated mainly in the earlier planted cotton, commenced late in January and persisted throughout February. During the second half of February crops began to suffer from drought, and the shedding of squares and young bolls developed in intensity for the following weeks. By the end of March growth of cotton had practically ceased and some plants were dead. The cotton crop was produced mainly from January and February flowers, when bollworm activity was at its greatest. The flush of flowers resulting from new growth after April rains produced no crop.

Of the crops grown the drought affected late-planted "streak" resistant maize most. Peanuts planted on 11th November produced a fair crop, whereas peanuts planted 18 days later were very poor. December-planted soyabeans felt the full effect of the drought at fruiting and produced about 400 lb. per acre of seed. Hickory King maize planted at mid-November did very well, yields of grain being from 10 to 16 bags (200 lb. each) to the acre. The best crop of maize, 16 bags per acre, followed sunnhemp as a green manure. Later-planted "streak" resistant "P×H" maize yielded from 2 to 9½ bags of grain per acre.

All the varieties of *Hibiscus cannabinus* and of *Hibiscus sabdariffa* stood the drought remarkably well, at no time showing much sign of distress. In this respect they were better than cotton.

The average yield of seed cotton grown on the Station was about 700 lb. per acre, individual plots in the better fields yielding somewhat more than 1,000 lb. seed cotton per acre.

COTTON BREEDING.

Variety Trial.—The cotton variety trial was arranged in a triple lattice with 12 replications. Twelve strains were selected from the MU8 × BP52² material, and 10 from U4/8161 × Sea Island progenies, and these were compared with A2106, U4/5143 and BP52.

The trial was planted on 8th November. Germination was good, but early growth was somewhat retarded by cool, wet conditions. A severe attack of American bollworm developed towards the end of January and continued for some weeks.

The main results are given in Table 1.

TABLE 1.
VARIETY TRIAL, 1949-50.
(Triple Lattice. 12 Replications.)

Variety.	Type.	Seed Cotton	Lint Length.	Ginning.	Lint.
		lb./acre.	mm.	%	lb./acre.
A 7266	M	994	30.56	36.0	358
A 7261	M	987	30.40	36.2	357
A 7217	M	975	29.68	35.6	347
A 619	M	972	31.56	35.0	340
A 7215	M	965	30.68	35.2	339
A 7244	M	954	30.20	36.4	347
A 7250	M	952	30.16	35.5	338
A 7262	M	931	29.88	36.5	339
A 7258	M	921	30.00	36.8	338
A 2106	—	915	29.52	35.2	322
A 618	M	902	29.92	35.8	323
B P 52	—	884	30.68	33.6	297
A 7252	M	860	31.44	34.7	288
A 7643	S	843	31.80	33.0	278
5143	—	837	28.28	37.3	312
A 7860	S	830	29.20	34.6	287
A 7257	M	823	29.96	36.8	302
A 7930	S	767	30.96	35.3	271
A 7862	S	764	30.28	33.5	256
A 7560	S	720	29.44	35.0	252
A 7835	S	695	32.24	34.2	238
A 7816	S	685	32.04	33.9	232
A 7838	S	672	30.68	33.8	227
A 7834	S	662	32.20	34.0	225
A 7559	S	652	29.36	35.0	228
Sig. diff. at P = .05 ...		77	—	—	—

M = MU8 × BP52² progenies.

S = U4/8161 × Sea Island progenies.

The most noticeable feature of this test is that A2106 did not outyield all other varieties as it had invariably done in previous tests. In fact two of the MU8 × BP52² progenies outyielded A2106 significantly at the P = .05 level, whereas A2106 was only better significantly than 5143 and the U4 × Sea Island strains. None of the U4 × Sea Island strains was as good as any of the MU8 × BP52² progenies. In this respect results are similar to those obtained in previous tests. The variety 5143, which in previous tests had outyielded BP52, did not show up quite so well this year under the conditions of this test.

General impression of strains grown.—An opportunity was provided for studying the behaviour of cotton varieties under conditions of severe drought and heavy bollworm infestation which occurred at the time when plants should have been flowering and fruiting actively.

The vigorous-growing and sturdy-stemmed MU8 × BP52's showed up to advantage against the U4 × Sea Island group. Among the latter the following produced the least robust plants: A7453, A7559, A7834, A7835. A7643 was the most vigorous of this group. It would appear that, under the severe conditions of the season, plant vigour and earliness were important factors in determining yielding capacity. The MU8 × BP52 group produces sympodia which, apart from an occasional tendency to "cluster" and the opposite tendency towards too long internodes, carry their bolls well. The more compact A2106, with a large number of fruiting points on its lower sympodia, tends to lean over when carrying a big crop, especially when subjected to strong winds, and there may be some loss of crop from bolls lying on the ground, especially on irrigated soil.

It is hardly necessary at this stage to comment on the lint quality of the better MU8 × BP52 progenies. These were reported on in "Progress Reports" for 1947-48. Since then a copy of a later report, on 1947-48 material submitted to the Shirley Institute, has kindly been sent to me by Mr. D. MacDonald, and from this it appears that the MU8 × BP52 strains have again revealed their good spinning qualities, being better than the U4 × Sea Island group, in spite of the latter's having an Effective Lint Length equal to or better than that of the former. The spinning quality of BP52 grown under similar conditions is again superior to that of either of the above-mentioned groups.

During the course of handling of the seed cotton and lint of the material studied during the season, a favourable impression was created by the majority of the MU8 × BP52² progenies in such qualities as fineness, silkiness (as opposed to the harshness of, for example, A2106), staple, uniformity and "drag." In these "handling" qualities the U4 × Sea Island group exhibited more variability, harshness sometimes being in evidence, often associated with good lint length; some were very impressive.

Bulks for observation and Progeny Line re-selection.—Seventy-one bulks from MU8 × BP52² progenies, 54 from the U4 × Sea Island cross, 14 from U4 × Cambodia progenies, 7 from MU8 × Tidewater and some BP52 material were grown for general observation and for re-selection of promising material. From each of these groups a number of plants which gave a favourable impression in the field were taken for an examination of ginning out-turn, seed weight, lint length and lint regularity as judged by "halo" combing.

The bulk of this material came from MU8 × BP52² progenies, from which 500 selections were taken for analysis.

In field selection attention was paid to leaf hairiness, robust growth, monopodial development, compactness and spacing of nodes on the sympodia. Finally 156 selections were carried forward from the MU8 $\times$ BP52 group, 32 from Cambodia $\times$ U4, 34 from U4 $\times$ Sea Island and 21 from MU8 $\times$ Tidewater.

The seed cotton characters of the MU8 $\times$ BP52 group showed considerably less variability than did those of the U4 $\times$ Sea Island.

"Storm-proof" and "picking" qualities.—In general it was found that the MU8 $\times$ BP52 lots were easily picked and at the same time seed cotton clung to the "burrs" (opened capsules) rather well for extended periods. Furthermore the bolls of this group are moderately large and easily accessible on a well-developed plant framework.

Under similar conditions the majority of the U4 $\times$ Sea Island progenies were inclined to shed their seed cotton easily, often soon after boll-opening. They "pick" easily but many of the progenies have smallish bolls.

U4 $\times$ Cambodia progenies were easily picked, perhaps more so than any of the other groups observed, but shed their seed cotton more easily than did the MU8 $\times$ BP52 group.

The Tidewater $\times$ MU8 group exhibited much variability in this character. Some progenies "shed" very readily indeed, whereas at other extreme were those with seed cotton held very tightly within the opened boll, more so than in the case of any other cotton grown at the Station this season, with the exception of Sea Island. The "shedders" were found to be rather short-stapled and to exhibit very poor "drag." Some progenies are still segregating for these characteristics.

Small observation plots of wilt-resistant and susceptible varieties were established on wilt-infected soil. Facilities were not available for inducing artificial inoculation to test for degree of resistance, but a number of crosses were attempted between healthy plants, selected mainly adjacent to diseased ones, of the two wilt-resistant varieties from Uganda, B181 and KP28 and selections from MU8 $\times$ BP52² progenies and from 5143, A2106 and MU8.

INSECT PESTS.

The unexpectedly heavy American bollworm attack at the Station led to the making of arrangements to undertake dusting. However, there was delay in procuring equipment and material, and dusting with 5% DDT, 5% DDT with 3% Gamma BHC, and an "Agroicide" dust containing, in addition to the above ingredients, powdered sulphur, were not effective. It was realised that dusting was commenced too late and that, to be effective, it would have to be carefully timed to catch a big proportion of the larvae soon after hatching. During February the cotton plants began to suffer from drought followed by the shedding of squares and young bolls; bollworm larvae disappeared and no new attack developed.

Only a small amount of Sudan bollworm appeared in late-developed bolls which managed to survive the dry conditions.

As was to be expected aphids (*Aphis gossypii*) and red spider (South African species not yet determined, but probably *Tetranychus* sp.) were encouraged where DDT was used. Aphids were troublesome from December onwards, but, except where DDT was applied, was subsequently controlled by predators. Red spider also developed where DDT and gamma-BHC were applied and did considerable damage late in February and in March.

Whereas sulphur dust is used effectively for the control of red spider in the U.S.A. and is often added to DDT and BHC preparations, it is found to be quite useless for the control of the red spider found on cotton in South Africa.

Stainers.—Both *Dysdercus nigrofasciatus* and *D. fasciatus* began to appear in increasing numbers once boll maturation commenced. However, as very few young bolls developed after their appearance in any numbers, there was little opportunity for them to do much boll damage. Whereas *D. fasciatus* bred up in considerable numbers this season, it was rarely seen at the Station a year ago. Although light frosts occurred in May, all stages of both species of stainer were observed subsequently in cotton fields and trash.

Boll rot.—Reports were received, particularly from the lower de Kaap valley, of extensive damage due to "boll rot." An opportunity to examine such damage did not occur until late in the season. "Mummied" bolls examined at this stage almost invariably showed no evidence of bollworm injury but in most cases stainer punctures through the boll walls were found. This evidence does not exclude the possibility that bacterial boll rot (*Xanthomonas malvacearum*) may have caused some of the damage.

It is of interest to note that two fields some hundreds of yards apart were examined. On the one field, which had been heavily manured, growth was tall and dense; on the other, of lower fertility, the plants were considerably smaller and were spaced more widely apart, there being many gaps in the rows. There was proportionally more damage from "boll rot" in the poorer field, amounting practically to a total loss of crop, whereas the denser-grown field was producing a very small crop.

VERTICILLIUM WILT IN COTTON.

Apart from the cotton wilt which has become established in portions of the Station's fields and which was in evidence again this season, a bad attack was reported from the Magut area in northern Natal in January. This occurred during a period of fairly heavy rainfall.

Another attack was reported later in the season at Kaapmuiden, in the lower de Kaap valley. This was in vigorously growing late-planted cotton, irrigated, and in the early flowering stage.

An inspection of fields of irrigated cotton in the Pongola River area was made early in June. Scattered areas showing typical symptoms of *Verticillium* wilt in an active stage were found and in one field in particular the extent of infection was very high indeed.

Incidentally, in this area some cotton fields had already been chopped out without any cotton having been reaped. Plant growth was magnificent but the crop had been denuded by successive waves of bollworm. At the time of the visit spiny bollworm (*Earias* sp.) and a smaller proportion of Sudan bollworm were infesting practically every square and young boll examined.

"STREAK" RESISTANT MAIZE.

In co-operation with the College of Agriculture, Potchefstroom, inbred lines of maize were tested for streak resistance. Inbred lines of the more promising lines, exhibiting a high degree of resistance, was collected for future work.

"Top" crosses of "streak" resistant " $P \times H$ " maize on to standard varieties of white dent maize were tested in seven randomised blocks for grain yield and "streak" resistance.

It was found that :

- (1) the locally bred " $P \times H$ " maize exhibited the highest degree of resistance, being almost completely resistant under the conditions of the test,
- (2) the hybrids (F_1) between "streak" resistant and non-resistant varieties exhibit an intermediate degree of resistance,
- (3) a variety of maize may be susceptible to "streak" and yet outyield a "streak" resistant variety under conditions favourable for "streak" development. In this particular test the strain of maize showing the highest "streak" infection (a double cross) also yielded the most grain.

However, it must be borne in mind that under certain conditions the "streak" virus may be so active that only resistant varieties will be capable of producing a crop.

- (4) a "top" cross between a susceptible and a "streak" resistant variety may produce an F_1 yielding better than the susceptible parent under conditions favourable for "streak."

HIBISCUS.

In November, 1949, the Station received a small quantity of seed of 16 varieties of *Hibiscus cannabinus* and 4 of *H. sabdariffa* from Mr. Pieter Koch of Pretoria. As the quantity of seed was small in most cases, the varieties were grown mainly for seed multiplication and general observation of plant behaviour. However, sufficient seed of two Egyptian varieties (Teal) and two Brazilian was available for small replicated yield tests and another test to determine the best stage at which to harvest. Samples were retted at the commercial plant of the Fibre Spinners and Weavers, Nelspruit.

The following is a summary of notes made on vegetative behaviour :

Source.	Vigour.	Branching.	Earliness.	Urticaceous hairs on stem.	Yield.
Manchurian and Chinese ...	—	—	Very early	—	—
El Salvador	Very robust	Nil	—	Absent	—
Brazil	—	Excessive	—	Bad	Excellent
Egypt	—	Nil	—	Absent	—
Wild "Stokroos"	—	—	—	Bad	—

Variability among both the indigenous "Stokroos" and the imported species and varieties is marked and about 100 promising selections were made.

It was found that Hibiscus flowers can be selfed artificially in the same way as cotton flowers.

Some of the varieties of Hibiscus were attacked by rust (*Aecidium Garckeanum*) at the time of flowering and seed-setting and when the plants were practically fully grown. Infection was heaviest in the Egyptian varieties and only slight in Brazilian.

Both plants and seed are very liable to insect damage.

SOIL FERTILITY-PLANT RELATIONSHIP.

Some preliminary soil and plant analyses were made by the Division of Chemical Services, and the following tentative indications were noted :—

- (1) Available phosphorus was generally extremely low.
- (2) Potash is rather low, indicating that crops with a large requirement of potash will respond to K fertilisers. This confirms the results of fertiliser trials conducted earlier at the Station.
- (3) Although reserves of Ca and Mg are still sufficient, continued cropping for a few more years without additions of these elements will lead to a deficiency.
- (4) The "camp" field, which has been under cultivation for a shorter period than the main fields at the Station appears to have bigger reserves of available phosphorus, nitrogen, potash, exchangeable calcium and magnesium. This indicates that under the system of soil management practised, soil fertility is not being maintained.
- (5) No reason can as yet be advanced for the poor and good patches of cotton in the "camp" field as revealed by the early growth of the crop.
- (6) Chemical analyses of cotton plants, when compared with American figures available, suggest that plants on the Station's red loam soils take up proportionally more potash but considerably less sodium than do cotton plants on certain South Carolina soils.

Rapid colorimetric analyses of the "granite" soils of the Station reveal a deficiency of nitrate nitrogen, phosphorus and potash.

A nutritional deficiency was revealed in patches of cotton on two adjoining farms near Barberton, the soil being probably of dioritic origin, deep and well drained. A reddening, drying and shedding of leaves occurred in plants which were already flowering and fruiting. There was no jassid nor could specific plant disease be detected. A chemical analysis of the soil indicated that any lack of one or more of the major elements was probably not the cause but there was an excess of active aluminium which might be proving toxic. The fact that abnormal symptoms appeared with an increase in soil dryness and later disappeared when rains fell, strengthens the opinion that a toxic soil condition was produced at the time that the soil solution was concentrated.

PROGRAMME FOR 1950-51.

1. Two cotton variety tests, comparing in the one case 25 strains, mainly of U4 $\times$ Sea Island progenies and MU8 $\times$ BP52 progenies, and in the other 9 strains of varying origin, will be conducted.

2. Single plant selections of cotton will be grown in duplicated plant rows for examination and selfing. Bults of the more important groups of cotton breeding material will be carried forward for further study. A close examination will be made of variety A2106 grown from selfed seed to study its components and degree of variability.

3. A study of cotton varietal resistance to wilt (*V. dahliae*) including the F_1 of crosses made the previous season.

4. Continuation of an experiment laid down by Dr. G. M. Wickens in 1948-49 and designed to test the influence of the application of fertilisers and compost on the behaviour of the cotton wilt organism in the soil. (See progress report for 1948-49.)

5. Fertiliser trials with cotton and *Hibiscus cannabinus* on granite soil.

6. Fertiliser placement with cotton and *H. cannabinus*.

7. Cultural and variety experiments with *H. cannabinus*.

8. Pest and disease control in *H. cannabinus*.

9. Breeding of "streak" resistant maize.

The past season has shown that it would be virtually impossible to control soil erosion at the Station unless the cultivated fields, which have a general slope from 3 to 3½ per cent., were contoured.

Furthermore in spite of root-cutting round the edge of the fields with a special root-cutter twice during the season, the root effect of *Cassia siamea* windbreaks was observable in crop growth up to 75 feet from the tree trunks.

The programme of tree-belt removal and contouring commenced earlier this year is being continued. The process will probably be spread over 3 or 4 years. In the meantime, because of the soil variability introduced by new fields cutting across old fields, roads and former windbreaks, much of the land will not be fit for detailed experimental work for some years and a full programme of field experimental work may not be possible for some time.

APPENDIX.

U4/5143 or 5143	A strain of hairy Upland selected at Barberton from U4.
BP52	An Upland variety important in Uganda.
MU8	A compact, hairy Upland type from India.
A2106	Bred at Barberton from a cross between a Cambodia and selection from U4.
A618 A619	From a cross between U4 and BP52 back-crossed to BP52.
A7215 to A7266	From a cross between U4 and BP52 back-crossed to BP52.
A7560 to A7930	From a cross between U4/8161 and Sea Island.
B181	A wilt-resistant cotton from Uganda.
KP28	Selected from B181 by Mr. J. D. Jameson.

NORTHERN NIGERIA.

PROGRESS REPORT FOR THE SEASON 1949-1950

Agricultural Circumstances.

BY

H. E. KING.

Normal Planting Period	... Late June to August.
Normal Picking Period	... Late November to February.
Rainfall (at Samaru)	... 39 inches, all within the period March to October inclusive.

The inherent agricultural circumstances under which the work on cotton is being carried out have already been described at length (1943-44 Progress Report); they remain substantially unchanged but with a continued increase in the interest being taken in cotton as a profitable and much needed export crop. A very satisfactory increase in the demand for seed resulted in a 17 per cent. increase in the total issue compared with 1948-49, widely and fairly evenly spread over most of the issuing centres.

The total rainfall for the season at Samaru was 38.93 inches compared with an average for the previous 25 years of 44.12 inches. The monthly totals were well below average for April, June and July, but that for August (16.39 inches) was unusually high. The first part of September was also unduly wet but an almost complete cessation of rains after the 12th resulted in a monthly total below average. The crop was thus subjected to a period of excessive rain (21.3 inches in 40 days between 4th August and 12th September) with high humidity and prolonged cool overcast periods, followed by an abrupt change to warmer, sunny and extremely dry weather.

This combination of a late start to the rains, high rainfall in August and early September, and an unusually early finish, was fairly general over the main cotton-growing areas and the weather on the whole could not therefore be regarded as particularly favourable to high yields.

Over the cotton-growing areas as a whole yields per acre were probably but little above those of last season. The total crop purchased for export showed an increase of about 20 per cent.—little more than proportionate to the increase in seed issued.

At Samaru, presumably as a result of the early cessation of the rains, the crop commenced opening early and an unusual proportion of the total yield was picked before the end of November. In consequence the results obtained from trials, and particularly from the comparison of early-cropping imported types with local strains, must be taken with some reservations. An indication of this is given by the ginning percentages of Allen and 26C, which showed a smaller difference than that recorded in any previous season, although the difference was still substantial in favour of 26C.

Red bollworm (*Diparopsis*) and Spiny bollworm (*Earias* sp.) were present from early in the season but the percentage of damaged bolls was in general not very high and most of the bud and boll shedding can be attributed rather to physiological stresses arising from inequable water supply. Bacterial blight (*Xanthomonas malvacearum*) in its three forms of angular leaf spot, blackarm and boll lesions was widespread while jassid, aphid, leaf-roller (*Sylepta* sp.) and mites (*Hemitarsonemus*) were all recorded as doing some damage. Stainers (*Dysdercus* sp.) were relatively unimportant this season and Pink bollworm (*Platyedra*) incidence was not heavy.

Giant crickets (*Gryllidae*) were troublesome in the experimental plots, causing considerable losses, even of quite large seedlings, in spite of persistent counter measures.

In some plots insects of the Genera *Lygus* and *Campylomma*, not previously reported as pests here, were found in association with very considerable tattering of the foliage and shrivelling and shedding of extremely small buds, the damage being similar to that caused by *Lygus vosseleri*, which is a serious pest in East Africa.

Monkeys did some damage, some cotton was lost by theft and goats interfered with one experiment.

Although the cumulative effect of the various pests and diseases was undoubtedly considerable, none was outstandingly serious and the yields recorded were in fact high for Samaru, reaching figures of 600 to 800 lb. of seed cotton per acre in several experiments with a maximum of over 970 lb. (average over seven replicates) for two progenies of 26C origin.

Part of the area used for cotton was land newly cleared for the purpose. This gave lower yields than the long-established plots and proved disappointingly irregular in fertility for experimental work. Further land was cleared and ploughed during the season in the hope that very thorough preparation well in advance would reduce the irregularities in next year's plots.

COTTON BREEDING

BY

H. E. KING.

INTRODUCTORY NOTE.

The transfer, to an officer of the Corporation, of all the cotton breeding work of the Northern Provinces took place at the commencement of this season in accordance with arrangements referred to in the programme of work attached to last season's report.

All the cotton breeding material, including single plant selections, small bulks from progeny lines and numerous strains under trial, was handed over by the Botanist previously responsible for this work. Temporary laboratory accommodation, such equipment as was available, an area of land and three members of the Botanist's junior staff were also handed over, the whole representing a very generous share of the limited resources of the Botanical Section.

Arrangements were made to share clerical and accounting staff with the Botanist and to organise the cotton work as a sub-section of the botanical work, rather than as a separate establishment, thereby relieving the Corporation officer of much of the routine office work associated with a Government department.

The equipment available at Samaru was supplemented by some items made available from the Barberton station of the Corporation and orders were placed through the Crown Agents for many other items required. An additional farm store was built during the season and the construction of more adequate laboratory buildings commenced. The staff was augmented during the season by additional transfers and local recruitment.

The writer wishes to acknowledge gratefully the help given by the Director of Agriculture, the Deputy Director, Northern Provinces and his staff in all these arrangements, and particularly the whole-hearted co-operation of the Botanist, Mr. J. H. Gisborne, which enabled the immediate planning and putting into operation of a breeding programme making full use of the material already in existence at Samaru.

INTRODUCTIONS FROM ABROAD.

Two introductions from Tanganyika, UK46 and UK48, were received. The former having been two years in transit showed only a very low percentage viability and could not be adequately tested. The second (which is the better of the two in Tanganyika) did quite well and will be tried again.

Twenty-five types from Barberton (South Africa) were imported. The more important of these were crosses having MU8 as one parent. MU8 itself has been shown to be a high yielder at Samaru but is not up to the required lint quality. Reference to the behaviour of these is made in a later section.

Two strains arising from selections originating from West Africa were received from the Sudan, where they had been found highly resistant to blackarm. Seed was sufficient only to raise a few plants for observation, but one of the two, BAR D28, was considered extremely promising.

SELECTION WORK.

From the breeding material already available at Samaru, 108 single plant selections were chosen for growth as progeny lines representing "Samaru 26C" (an improved substrain of Allen), and "Maiduguri material" predominantly of Allen character but of mixed origin and showing some "*punctatum*" characteristics. Duplicate plots were planted in all except a few cases where seed was insufficient. Growth and yields were good and a very large number of reselections were selfed and harvested. In general the progenies derived from Maiduguri selections were inferior to the 26C material and only a small number were retained after laboratory examination. From the 26C selections, 128 single plants were chosen for progeny row tests representing thirteen families, all dating back to original selections from bulk 26C made in 1947. All the families showing promise in the "Strains Test" (see below) were represented in this material. Considerable genetic variability within families was evident in many cases and in general the material gave indications of yielding conspicuous improvements over 26C in a number of respects.

In addition to the above, nearly a thousand new single plant selections were made from bulk in plots planted with 26C, relatives and derivatives of 26C, D5 (a predecessor of 26C), and a number of the more promising of the introduced types. All these were subjected to laboratory examination and gave valuable indications of the variability existing in the various strains as well as selections to carry forward to next season.

An example of the variation found in the course of this selection work is provided by a set of 200 plants taken from a single half acre plot sown with selfed seed of 26C. The plants were selected as above average in fruitfulness, and of good robust healthy growth, after the field had been heavily rogued. A random sample would presumably have covered a wider range but would have provided only a small proportion of plants with adequate seed for progeny tests. The average yield per plant over the whole field was about 16 grams. of seed cotton only.

TABLE 1.
Ranges and Mean Values displayed by 200 Single Plant Selections from Samaru 26C.

Character and unit of measurement.	Range.	Mean Value.
Yield of Seed-Cotton (grams.)	19—166	51
Ginning Percentage	29.3—40.2	36.1
Seed Weight (mgms. per seed)	62—114	87.5
"Lint Equivalent"* (mgms.)	40—64	54.2
Lint Length (mms., Bailey Halo)	29.7—36.5	33.3

* A modified Lint Index, obtained by assuming a mathematical relationship between seed weight and surface area and calculating the weight of lint per unit area of seed surface instead of per seed, the unit being equivalent to the surface area of a seed weighing 100 mgm.

REPLICATED TEST OF STRAINS AND SMALL BULKS.

A comprehensive replicated "Strains Test" was planted in order to compare as closely as possible a large number of small bulks, derived from previous selection work at Samaru, together with a wide

range of imported types, using 26C as control and including also two stocks of Allen, to give a total of 72 "strains." With so large a number it was possible to grow only quite small plots and the unit plot size was a single ridge of 12 yards containing 23 stands thinned to two plants per hole. Seven replications were used.

Observations on growth, botanical characters and resistance to pests and diseases were carried out on all these plots, taking up much time but providing data amenable to statistical analysis and thus providing a much firmer basis on which to reject or select for further trial. Composite samples in quadruplicate from all strains were taken for ginning, lint samples and laboratory tests.

Preliminary examination indicated certain groups of strains of little promise, and these were discarded without further study. Statistical analysis was confined to data from the better groups and revealed significant differences in almost all the characters susceptible to numerical treatment. In particular differences between the 26C derivatives were demonstrated for the following characters :—

Proportion of plants showing severe leaf fretting ascribed to *Campylomma* sp.
Ginning Percentage.
Seed Weight.
Lint Equivalent.
Halo Length.
Reaction of Lint to Differential Dyeing.

The general conclusions from the whole experiment may be summarized as follows, the strains being dealt with in groups according to origin and general type :—

(i) None of the relatives of 26C (viz. 26E, F, G, H and I) shows any substantial all-round advance on 26C itself and none need be given further trial as it stands. Single plant selections will be carried forward from all. 26I was one of the best in a number of characters (see also under Variety Tests later), but was distinctly shorter-linted than 26C.

(ii) There were marked differences in botanical characters, resistance to insects, seed cotton yield, ginning percentage and lint length amongst 16 small bulks descended from re-selections from 26C. The best of these, No. 4721, was in fact the highest yielder amongst the whole 72 strains tested, giving an increase in lint yield of approximately 20 per cent. over 26C. In characters other than yield also this selection was more satisfactory than most, but it was rather below the standard of 26C in resistance to jassid and slightly shorter-linted.

(iii) A stock of Allen seed ex Wase, obtained from Zaria ginnery, did not differ in general characters or in yield and ginning per cent. from "Funtua Allen" previously used as the standard of comparison. There was some suspicion that the Funtua stock might have become "graded up," compared with the original Allen by admixture with seed issues of the predecessors

of 26C (e.g. D5, D8 and D30) in the past, and Allen from a more remote area was therefore obtained for comparison. There is however no guarantee that this latter is entirely "unimproved Allen."

(iv) The lint yield of 26C in this experiment was 17 per cent. above that of both the Allen stocks but (as in other experiments this season) the difference in ginning percentage was little more than 2 per cent.

(v) None of the bulks derived from the Maiduguri selections is worth further trial. A reserve of seed is being kept.

(vi) Of other lines derived from selection work in the commercial crop, two strains, L2x and L5x, are worth further trial.

(vii) Quite a number of the strains introduced from South Africa proved very distinctly earlier cropping than 26C but none showed a really substantial advance on 26C in final yield of seed-cotton and most gave a lower ginning percentage. The majority seemed too susceptible to blackarm for local conditions as they stand. If more resistant sub-types can be bred from them they should prove strong competitors with local types. Further trials are needed to determine to what extent their earliness is an advantage in other seasons and districts. The MU8 × BP52 hybrids were amongst the best in yield and on preliminary examination seem at least the equal of 26C in lint characters.

(viii) Of strains from East Africa, UK48 was above 26C in seed-cotton yield and almost equal in lint length, but gave a much lower ginning percentage. Uganda BP52 yielded poorly but a blackarm resistant derivative BAR. 12/3 did better and seems worth further trial.

(ix) The behaviour of 13 earlier introductions under renewed trial in this test followed in general that recorded for previous seasons. All except MU8B (UA7-44) were so markedly inferior as to merit no further attention.

VARIETY TESTS.

Tests to compare various stocks of 26C, from successive stages of the seed multiplication scheme, with related strains and with commercial Allen seed, were carried out at Daudawa (with the co-operation of the officer in charge there) and on two sites with differing soils at Samaru.

No interaction of strain with site could be proved and the results were therefore combined, giving comparisons based on 24 replications in all. These gave an average difference in ginning percentage between 26C and Allen of 2 per cent. only, against a general average

in previous seasons of 4 to 5 per cent. The reason for this is not clear but the figures were consistent for the three experiments and a similar difference was obtained with samples from a test of the two strains grown by the agricultural officer at Gusau, so the effect must perhaps be regarded as a general seasonal one.

With this reduced difference in ginning percentage, 26C still averaged a 7 per cent. increase in lint yield over commercial Allen. There was no great difference between the stocks of 26C but Stage 3 seed (the furthest removed from the pure nucleus stock) was a little inferior in yield.

Of the relatives of 26C, only 26I showed any marked improvement in yield and its performance over the three tests was inconsistent. As in the "Strains Test" (see above) its lint length, judged on halo measurements at Samaru, was unsatisfactory.

OTHER EXPERIMENTS.

The permanent rotation experiment, designed to give a series of data for studying seasonal fluctuations, was continued. Yields of seed-cotton were about 30 per cent. below those of last season (averaging 305 lb. per acre against 444 lb. in 1948-49).

A small experiment intended to provide material for a study of the effect of late planting on lint maturity was planted on August 9th and served as a useful demonstration of the depressing effect on growth and yield of delay in planting. The crop produced was less than 50 lb. seed-cotton per acre.

SEED MULTIPLICATION.

An isolated half acre plot of 26C sown with selfed seed was grown as a "Nucleus" to produce seed for the "Stage O" of the Daudawa seed multiplication scheme. Low seed rate and heavy roguing (resulting in the removal of some 7 per cent. of the plants—chiefly for lack of adequate jassid resistance), left a poor stand, but a yield of approximately 600 lb. of seed-cotton per acre was obtained and over 170 lb. of seed made available for sowing at Daudawa.

In co-operation with the Senior Agricultural Officer in charge of Daudawa, a scheme to speed up the multiplication of 26C seed has been worked out and the first step—a doubling of the area of "Stage O," making it 20 acres—is being put into operation in the 1950-51 season.

This scheme is designed to multiply the nucleus stock issued for "Stage O" in any one year to a quantity sufficient to cover the total requirements of the Northern Nigerian crop seven years later. This is a reduction of two years in the period required compared with the scheme previously in partial operation and at the same time allows for a larger final acreage.

LABORATORY WORK.

Much time was spent in training staff in various laboratory routines and in devising equipment and apparatus. The process of delinting seed with sulphuric acid has been introduced in preparing seed for next season. Trials were made of the technique of "differential dyeing" for estimating lint maturity and progress was made in developing and testing a routine method for this.

SPINNING TEST RESULTS ON 1948-49 SAMPLES.

Reports on the samples sent to England for spinning from the 1948-49 season's experiments may be summarised as follows :*

(i) Samples from Daudawa Variety Test were all of unusually poor quality and showed only small differences between strains. 26I and 26C were about equal and were somewhat superior to Allen in maturity and yarn appearance while being a little inferior in lea strength. As regards 26C this result is in accord with previous tests but 26I has previously done better and this season's result is disappointing.

(ii) Samples from the two Samaru tests—A10(48) and A11(48)—showed that none of the imported strains, whether early or late sown, was the equal of 26C in yarn strength. The yarns from late sown samples were consistently weaker and poorer in appearance than those from the same strain sown early. As at Daudawa all samples, including 26C, were of low quality.

(iii) Twenty samples from the 1948-49 breeding plot, representing small bulks from progenies of 26C origin, were spun with a comparable sample of 26C itself. The results were most disappointing; of the twenty, only two gave yarn strength as high as 26C and fourteen were significantly inferior, the worst being as much as 30 per cent. down. Moreover, of the two with yarn strength as good as the standard, one gave a very low effective length (34 against 37 in 32nds of an inch) and the other was extremely immature ($N-D=29-36$).

These progenies, amongst which were those included in the current season's "Strain Test" referred to in an earlier section, were from selections made for better fruiting. It seems clear that, in attempting to improve the yielding powers of 26C, the greatest attention will have to be given to preserving its spinning quality unimpaired. It is fortunate that the highest yielding bulk in the Strains Test, No. 4721, was not one of those significantly inferior in yarn strength, being only about 5 per cent. down.

(iv) Samples from a 1948-49 Date of Sowing Trial at Samaru showed that length and maturity of the lint hairs, and strength and appearance of the yarn, fell off with later sowings and also,

* Acknowledgements are due to the British Cotton Industry Research Association for carrying out these tests.

on the whole, with successive pickings from each date of sowing. These results support those from a similar test of the previous season but with more clear-cut differences. The importance of early sowing as a factor in keeping up the quality of the crop is thus confirmed.

(v) Samples from a small experiment, referred to in last year's report and designed to produce big differences in lint maturity, gave disappointing results. It is clear from the yields of seed-cotton and other data that the growth and fruiting of the control plot was quite unusually good. In consequence even the most extreme treatment, which was ten tons of farm-yard manure and copious hand watering right through the period of boll ripening, had no apparent influence on growth or yield, and its effect on the measurable lint characters was quite unspectacular. In the case of the late December and January pickings there was a fairly well-marked difference in hair maturity in favour of the watered plots but this was not reflected in either the strength or the appearance of the yarn.

Watering at a rate equivalent to half an inch of rain every three days throughout October and November had no discernible effect whatever on the sample from the first picking, taken on 23rd November, in comparison with the unwatered control and in the absence of appreciable rainfall after the end of September.

PROGRAMME FOR 1950-51.

Single plant selections are being grown in replicated progeny row tests. One containing 128 progenies in sevenfold replication comprises 26C material arranged in families of eight progenies each, in a design utilizing "interlaced" balanced incomplete blocks. It is considered that this arrangement will improve the accuracy of comparisons between families while retaining, in part at least, most of the advantages of the compact family block design.

A set of 144 selections from bulk 26C has been arranged in a separate experiment and is intended to give material for bulking as a new stock of purified 26C type for immediate multiplication. Seed of many of the plants was sufficient for only four replications but it is considered that these will provide an adequate basis for roguing out progenies falling below the general standard in the more easily observed field and laboratory characters.

Seed from 78 further single plant selections has been planted in duplicate rows for observation and further selection work, and numerous small bulks have also been planted for the same purpose.

Variety tests containing Samaru 26C, some of its more promising derivatives and a few of the most promising of recently introduced types, are being grown at Samaru and four points widely scattered within the Northern Provinces (Kano, Gusau, Kontagora and Zonkwa).

It is hoped that these will give useful indications of the relative value of the various types under a range of conditions, in particular as regards the earlier cropping character of the introduced strains.

A test is being carried out at Samaru and Daudawa of the 26C seed stocks from various stages of the multiplication scheme together with samples of the commercial stocks of Allen in use in three localities.

One further test, at Samaru only, includes a few further strains and small bulks of interest.

A number of minor field experiments and observation plots have been planted in connection with shedding, lint maturity, effect of acid treatment of seed, reaction to pests and diseases and seasonal variations.

Laboratory techniques, capable of employment locally, for estimating some of the characters influencing lint quality are being further developed with the emphasis on simplicity and speed. In particular a method, whereby very large numbers of small samples of lint hairs can be subjected to "differential dyeing" quickly and easily, is being further tested.

Co-operation with the officers in charge of the Seed Multiplication Scheme and the Cotton Development Programme is being maintained and plans for the more rapid multiplication of seed of 26C kept under review and pressed forward actively.

ENTOMOLOGY

BY

Q. A. GEERING.

The work centred at Samaru and Daudawa, on the lines indicated in last year's report, has been extended further afield, and full-time studies of bollworm and stainer populations have been started at Gusau, Kontagora and Ibadan.

SEASONAL ACTIVITY OF PESTS.

*Red Bollworm (Diparopsis sp.)**

The pattern of emergence of adult moths has so far been followed through one complete annual cycle only at Samaru, and is shown in Fig. 1.

Emergence from Long-term pupae formed in 1948.

Two distinct periods of emergence were apparent. The first extended from early June to early July with a peak in mid-late June ("a" in Fig. 1). The second emergence ("c" in Fig. 1) commenced in early October and ceased at the end of the month: the peak was well-defined during the second week of October. These were the only two periods during which moths emerged from long-term pupae.

* Recent work at the British Museum (not yet published) suggests that the Northern African *Diparopsis* is distinct from the true *castanea*.

Emergence from Short-term pupae formed in 1949.

Two periods of emergence occurred, associated with those of the long-term emergence. The moths emerging from long-term pupae in June laid eggs on standover and ratoon cotton, and the pupae formed from these were wholly short-term, producing a generation of moths which showed a peak emergence in early to mid-August ("b" in Fig. 1). The moths emerging in October were able to breed on the main cotton crop, and gave rise to moths which emerged from late October to early November ("d" in Fig. 1). A small fraction of the larvae collected in the main crop would have originated from moths which bred on ratoons. The early part of "d" in Fig. 1 thus would include moths arising from these. The pupae produced from mid-October onwards showed an increasing proportion to be in diapause (Table 1) and it is evident that not all of the long-term moths emerging during October are able to produce a further flight of moths. The 1948 emergence during November is included in Fig. 1 for comparison.

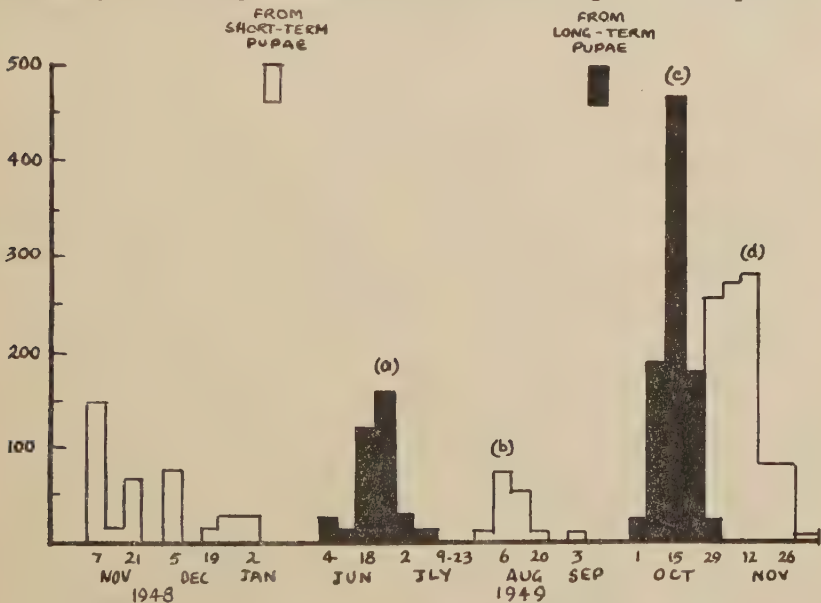


FIGURE 1. *DIPAROPSIS*: MOTHS PER ACRE PER WEEK SAMARU, 1948-49

TABLE 1.
RED BOLLWORM STUDIES. DEVELOPMENT OF DIAPAUSE. SAMARU, 1950.

Period of collection of full-grown larvae.										Per cent. of pupae not short-term.
September	11—1st October	...	...	...	...	...	...	...	...	0
October	2—8th "	...	...	...	...	...	...	...	...	0
"	9—15th "	...	...	...	...	...	...	...	...	5.5
"	16—22nd "	...	...	...	...	...	...	...	...	9.7
"	23—29th "	...	...	...	...	...	...	...	...	37.8
"	30— 5th November	...	...	...	...	...	...	...	...	65.5
November	6—12th "	...	...	...	...	...	...	...	...	78.5
"	13—19th "	...	...	...	...	...	...	...	...	100.0

Note.—These figures are based on the numbers of "rattlers" * present in the cages in June, 1950, expressed as a proportion of the sum of these, plus moths emerged in 1949, plus parasites which emerged in 1950. Dead pupae are not included in the calculation.

* The earthen cells which when gently shaken give the sound and sensation indicating that the pupae inside are still alive.

The very marked separate periods of emergence from long-term pupae suggest that the June and October emerging moths may differ physiologically. The earliest moths emerging in the following June came from some of the later-formed pupae of the previous year. On the other hand, the development of long-term pupae may be arrested by the cool conditions prevailing during July-September. All development, however, is not arrested over this period, since short-term moths are produced during August (their period of development is longer than in October: cf, a—b, and c—d in Fig. 1). It may be therefore that the environmental conditions during July-September have different effects on long and short term pupae. One of the principal factors operating at the time is heavy rainfall producing waterlogging of the soil and comparatively low soil temperatures.

Development of attack.

Samaru.—The cycle of egg-laying here corresponded closely with the flight-periods of the moths, both on early ratoons and on the main crop. The curve for egg-count on the latter is shown in Fig. 2.

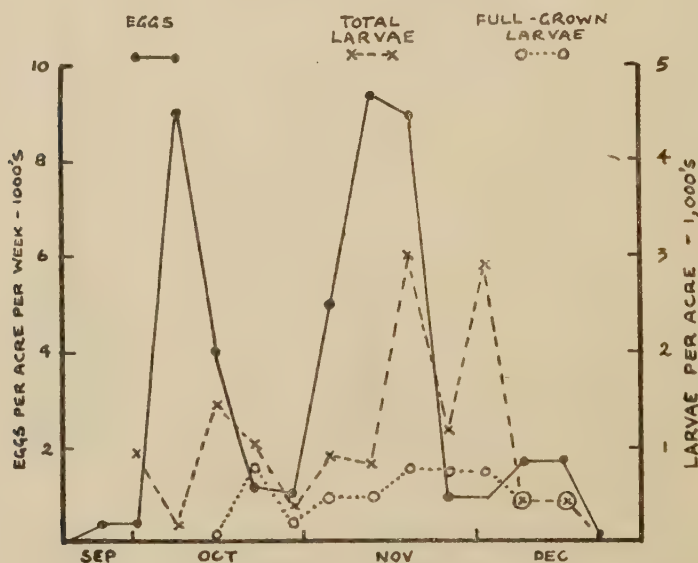


FIGURE 2. RED BOLLWORM POPULATIONS SAMARU, 1949

The first peak of activity occurred early in October, and the second, in November, was of the same magnitude of 9,000 eggs per acre per week, (in 1948 this second peak was much smaller than the first) and this season the attack came in two sharp well-defined waves. A small and brief resurgence of activity occurred in mid-December (as in 1948). The egg-laying was thus concentrated into two comparatively brief periods, and the peak numbers were higher than

in 1948: over the whole season eggs deposited averaged 2.7 per plant compared with 2.5 in 1948. The larval numbers again reflected the changes in egg-numbers but on a much smaller scale. Thus the two peaks exceeded the peak numbers in 1948, although taking the season as a whole the numbers were not greater than in the previous year.

Daudawa.—(50 miles N. of Samaru.)—On the main part of the multiplication scheme, sown in early July, egg-laying activity by *Diparopsis* remained at an extremely low level throughout October, but rose rapidly to a peak in the third week of November. Here again a small burst of egg-laying occurred in late December. Eggs per plant were calculated at 1.6. In a succession of sowings started on 1st June, oviposition on the earliest sowing started in early July; peaks occurred in early August, early October and early November. This pattern of activity, markedly different from that on the main crop sown in early July, suggests that the ratoons in the area enabled the first sowing to receive an early attack, and was then exposed to successive generations of moths bred in the crop, and to the emergence from long-term pupae in October.

Gusau.—(100 miles N.W. of Samaru.)—Here the attack commenced at the same time as at Samaru, but the two peaks of egg-laying were lower and oviposition was spread more evenly throughout the season. Eggs per plant averaged 5.1, but here the crop was thinned to only 1 plant per stand and the figure is directly comparable with that of 2.5 per plant at Samaru where stands were thinned to two plants, but at the same spacing. This clearly illustrates how the effect of bollworm attack is "cushioned" by increasing the plant population: in practice it has been found that 2 plants per stand give the best yields, probably owing partly to this effect.

Kontagora.—(140 miles S.W. of Samaru.)—Activity commenced and finished later here than elsewhere, and the main peak of egg-laying came during late November and early December. The last small burst of activity came in early January. The highest numbers of eggs laid in any one week were recorded here, namely 14,000 per acre. The total numbers of eggs laid were also greatest, averaging 5.1 per plant where stands had 2 plants.

Ibadan.—All the records referred to above were obtained in the Northern Allen belt, but records were also taken at Ibadan in the Southern belt, where Ishan cotton is grown. This ideally grows to a much larger plant than the Allen type of the north, and is planted at a wider spacing and thinned to one plant per stand. The crop is sown during July (as in the north) but has a longer growing period and crops much later. Here, however, Red bollworm activity again commenced during October, but remained at a low level until the end of November, when eggs laid per week numbered 3,000 per acre. A second major peak (7,000 per acre) came at the end of December and egg-laying continued on a diminishing scale until mid-February. Total eggs recorded averaged 6.4 per plant.

Larval numbers of *Diparopsis* exceeded those of all other species of bollworms at Kontagora, Daudawa and Gusau, where peak figures were 3,630, 1,024 and 1,806 per acre respectively.

The work has now been in progress for two seasons, and the Red bollworm studies show that this species is a constant factor in reducing yields. Populations and damage appear to increase southwards and these characteristics are probably associated with an increasing growing season.

Possibilities of control.

Indirect measures.—The moth-flight studies completed for one year at Samaru show that a proper close season should prevent the June-emerging moths from breeding, and activity on the main crop would commence only with the October emergence from long term pupae. Adjustment of the sowing date to set the crop before this attack (it cannot be entirely avoided), might give some increases in yield.

The main difficulty in enforcing a thorough close season is to ensure proper uprooting of the old cotton plants: cutting back to ground level allows a proportion to ratoon. In order to explore the possibility of large-scale uprooting, uprooting tools were used at Daudawa and the whole 130 acres of Stages 0 and 1 and all experimental cotton were cleared with these. Earlier experiments showed that it took 4 man days to uproot 1 acre of cotton, compared with $2\frac{1}{2}$ man days to cut it back. Unfortunately the settlement farmers, growing about 600 acres in the multiplication scheme, cut back their cotton before the uprooters were issued. It is expected to be possible to institute regular uprooting at Daudawa but in the remaining areas of the Allen belt the easier way to eliminate ratoons will probably be to encourage the farmers to remove them from the guinea-corn crops.

The magnitude of the October emergence will depend on what proportion of the moths emerge in June, and the time of the start of this second emergence from resting pupae will be largely determined by climatic conditions. Further study of the pattern of emergence and its relation with climatic conditions may suggest ways of reducing the proportion of moths emerging in October. Early cultivation of the land to expose pupae to predators would also reduce the October emergence. This is not generally practised by peasant farmers, who, at the first rains, plant guinea-corn in old cotton fields without previous cultivation. At Daudawa there is now a more thorough clean-up of cotton fields in the area, and elimination of ratoons. Here early cultivation is practised in April–May (to plant guinea-corn), mechanically on the main farm, and by cattle-drawn ploughs on the settlement farms. If early cultivation reduced Red bollworm populations this may account for the light attacks so far recorded in the area.

Direct measures.—The use of insecticides on the main multiplication scheme would be made easier if indirect measures could reduce the attack and restrict it to October–November. At that time there

would be only a few October showers of rain to contend with, and the insecticide would thus be able to exert its optimum effect. Trials with this method of control are dealt with in a later section of this report.

Other Bollworms.

Pink Bollworm (Platyedra gossypiella).

This species was "rare" in the Daudawa area, and was present in small numbers at Gusau compared with 1948. Highest populations were recorded at Samaru, Kontagora and Ibadan, where numbers of larvae in the ripe cotton were 4,636, 6,409, and 2,855 per acre respectively, and the proportions of the population of diapause larvae left on the field after harvest varied from 15.38 per cent. to 25.3 per cent. The species was predominant at Samaru and Ibadan.

A study of the fate of diapause larvae confirmed the results obtained in 1948. In old bolls left on the field the majority had pupated by the end of July. Numbers occurring in ginned seed were variable but generally low: of 78 samples examined only 13 contained living larvae, and the infestation in these averaged 7.4 per 10 lb. seed in the early part of the dry season. At the time of planting no living larvae were found in seed samples. The duration of diapause was studied by examining infested seed-cotton samples from February to June. Those larvae collected in each month were placed in tubes and their emergence recorded. Once removed from their cocoons the larvae pupated and emerged within 4-6 weeks: the period became shorter the later the larvae were collected, and no moths were produced after the end of July. The fact that pupae were only first found during June suggests that the act of removing the larvae broke their diapause, and the above results may indicate that in stored seed cotton the larvae do not normally pupate and produce moths until July. There was, however, one instance of a larva collected in January producing a moth in September.

The carry-over of Pink bollworm is, therefore, likely to depend as much on the existence of stored infested seed cotton as on old bolls in the field, and less on infested ginned seed. The carry-over could therefore be reduced by a proper close season, and buying of all seed cotton, including very poor grade. Daudawa is an area where these two measures already operate, and it may be related to the extremely small numbers of Pink bollworms occurring there during this season.

False Codling Moth (Argyroplote leucotreta).

This was present in any great numbers only at Ibadan, where the population reached 3,000 per acre. Elsewhere, and on the main crop, it appeared to be of minor importance, although the earliest sowings at Daudawa built up large populations.

Spiny Bollworms (Earias insulana and E. biplaga).

These were most active in the Kontagora area, but in other areas populations were lower than in 1948. During the dry season, the main

period of activity in all areas occurred from early March to early April.

American Bollworm (Heliothis armigera).

This was recorded for the first time at Daudawa and Kontagora, but on only two occasions throughout the season.

Stainers (Dysdercus supersticiosus).

At Daudawa, a plot of experimental cotton sown in early June suffered a heavy attack. Stainers first entered this crop in late August, and by early September adults numbered 7,000 per acre. On 20th September, early instars were present on the first split bolls. A second generation was bred in the same plot during October and November and damage to this and adjacent plots was severe. In contrast, the separate and later sown (early July) cotton on the main farm showed extremely low populations of stainers throughout the season, with correspondingly less damage.

In the other areas where the crops were sown during early July, stainers were first recorded in early October at Kontagora and Ibadan, and early November at Samaru and Gusau. Under these conditions one generation of adults was bred in the crop during November and December, and left the cotton during the harvesting.

This species has been found feeding and breeding on bulrush millet during August and early September in all the areas of the survey. The millet is harvested mainly during late August and early September, and the mass migration of adult stainers into the earliest sown cotton coincided with the harvesting of millet in that area. It seems therefore that there must be an effective gap between the millet harvest and bolting of cotton to avoid heavy stainer damage. This period seems to be adequate in some areas but not in others if the cotton is sown in early July. There is increasing evidence that *Hibiscus cannabinus* acts as a trap crop and its presence delays the entry of stainers into the cotton.

Other insects.

Jassid (E. facialis).

This insect occurs on cotton throughout the season, but, apart from producing a slight yellowing effect on the leaves of some plants, it severely damages only the occasional non-hairy types; it is clearly a potential pest but of no importance if hairiness is maintained.

Lygus vosseleri and *Campylomma* sp.

Both were swept from cotton in September, but *Campylomma* greatly outnumbered *Lygus*. Leaf-tattering damage was common but irregularly distributed. The role of these two insects in crop loss is not certain.

Aphis gossypii.

This colonised the plants early in August but was controlled by predators. Numbers increased again during October and November but caused no damage.

Thrips, Red Spider and "Acariose."

All were recorded, but were not sufficiently numerous to effect any severe damage.

Whitefly (Bemisia sp.).

These occurred throughout the season, but were most numerous in March on standover cotton. No virus symptoms were recorded.

CROP LOSS.

(a) *Shedding*.

Bud shedding was never heavy and mostly not attributable to bollworm. Only for short periods, at Samaru in early October and at Kontagora in mid-November, were bollworms responsible for a high proportion of bud shedding. The heaviest bud shedding was recorded at Daudawa in late November.

At all Northern stations boll shedding was heaviest during October and November, and everywhere exceeded bud shedding. The proportion of bolls which shed varied from 67 per cent. to 71 per cent. At Ibadan, the peaks of boll-shedding occurred during December and January, and this was the only locality where more than 55 per cent. were damaged by bollworm during the periods of heaviest shedding. Throughout the season, total shedding of buds and bolls was heaviest at Samaru, and in order of decreasing intensity came Gombe, Kontagora, Daudawa, Ibadan and Gusau. Taking the season as a whole, Kontagora showed the highest proportion of bollworm-damaged sheds, namely 50.4 per cent.

TABLE 2.
PER CENT. OF SHED BUDS AND SHED, ABORTED AND RIPE BOLLS DAMAGED BY BOLLWORMS.

Station.					Shed buds.	Shed and aborted bolls.	Ripe bolls.
Daudawa	...	...	...	...	51.20	21.25	16.80
Samaru Std.	...	...	...	...	34.92	23.49	52.95
Samaru Bot.	...	...	...	...	43.15	26.18	49.38
Kontagora	...	...	...	...	58.00	47.38	44.40
Ibadan	...	...	...	...	23.60	46.68	58.48
Yola	{ Local	...	...	...	40.05	35.63	91.79
		Upland	...	...	59.20	31.36	88.91
Gombe	...	...	...	...	41.65	28.37	52.88

It was suggested in the previous report that the sudden change in climate at the end of the rain was largely responsible for the heavy boll-shedding, and this opinion is still maintained. The results from all stations again suggest that bollworms are not primarily responsible, but there remains the possibility that some other insect may contribute

to shedding. Stainers cannot be incriminated, at least in the October shedding, since their numbers in the crop are generally small at this time, and heavy November shedding is not necessarily associated with large stainer populations. The roles of *Lygus* and *Campylomma* are not known, but results from the insecticides trials show that the heavy shedding was not reduced even by the best treatments, although these showed significant reductions in the proportion of sheds damaged by bollworm.

(b) *Damage to non-shedding bolls.*

The most striking feature of this season's results is the very clean cotton produced at Daudawa associated with low bollworm and stainer damage, and the very heavy loss recorded at Yola, mainly due to heavy bollworm damage. We do not yet know which species are involved at Yola since only ripe-boll samples were examined.

The non-bollworm damage shown in Table 3 can be mostly ascribed to stainers, and is not due to secondary rotting and staining associated with bollworm damage. This differentiation was achieved by grading bollworm and non-bollworm damaged bolls separately and estimating how much staining and rotting were independent of bollworm damage. "Non-bollworm partial loss" therefore refers to locks partly stained (by *Dysdercus*), and "Non-bollworm complete loss" to locks completely rotted.

The grading revealed the following features.

Daudawa.—The proportion of clean cotton was highest (86.36 per cent.), owing to low incidence of bollworms and stainers. Bollworm damage was about double that of stainers.

Samaru.—Clean cotton averaged 58.53 per cent. and there was a greater loss due to both bollworms and stainers, with the former again predominating.

Kontagora and Ibadan.—Stainers and bollworm contributed equally to the loss of crop. Only about 40.65 per cent. of cotton was clean at Kontagora, and 32.3 per cent. at Ibadan.

Gombe.—The loss due to stainers here, in the Eastern part of the Allen belt, was greater, and the cotton was only 34.0 per cent. clean.

Yola.—On the Eastern border of the country, Yola is at about the Southern limit of the area in which Upland cotton will grow successfully. The highest bollworm damage was recorded here, and stainer damage was negligible by comparison.

TABLE 3.
PER CENT. DAMAGE IN NON-SHEDDING BOLLS.

	Daudawa Stage 1	Samaru Std.	Samaru Bot.	Kontagora	Ibadan	Yola		Gombe
						Local	Upland	
Clean	86.36	59.01	58.05	40.65	32.30	21.21	17.60	34.08
Bollworm—								
Partial loss	3.62	11.16	16.41	23.45	18.58	32.40	29.84	12.57
Bollworm—								
Complete loss	4.48	16.11	14.92	6.90	20.35	42.42	43.91	12.37
Non-Bollworm—								
Partial loss	3.82	10.92	8.33	24.90	15.86	2.90	3.58	29.53
Non-Bollworm—								
Complete loss	1.72	2.80	2.28	4.13	12.91	1.06	5.07	11.46

Note.—Three settlement farmers in Daudawa area, growing Stage 2 in multiplication of 26C showed an average of 81.03 per cent. clean cotton on six plots from which ripe-crop samples were collected. The records obtained from Gusau gave a reliable figure for "clean" cotton only—viz., 69.3 per cent.

INSECTICIDE TRIALS.

These trials were laid down at Daudawa. This locality was selected in preference to Samaru, and was chosen because it was hoped to ascertain whether the use of routine sprays or dusts could give a substantially higher yield in the earlier stages of the seed multiplication carried out there. If this were possible, the expenditure might be justified for this purpose even though insecticidal treatment in general proved uneconomic.

Inevitably these trials were of a preliminary nature designed to investigate the possibilities of effective pest control by these means, and no economic limitations were imposed in the design of the trials. Two of these (Expts. 1 and 2, sown 14th June and 12th July) occurred in a succession of 3 sowings commencing on 1st June in an area where a heavy attack of all pests developed, and particularly an early attack of Red bollworm. The third was situated in a distant part of the farm, in a 120 acre block of cotton sown on 9th July.

A careful check, by routine sampling and population counts, was kept on the bollworm and stainer populations, but particular attention was paid to Red bollworm. Treatments were first applied, therefore, as soon as eggs of *Diparopsis* were recorded, and during August and the first three weeks of September were made at weekly intervals. Thereafter, since the rains had virtually ceased, two weeks elapsed between applications.

The following treatments were applied, randomised in four replicated blocks, with plots of $\frac{1}{40}$ th acre. Four Oaks knapsack sprayers and a knapsack duster were used.

1. 0.25 per cent. DDT emulsion + 0.008 per cent. gamma BHC.
2. 0.5 per cent. DDT Wettable Powder + 0.008 per cent. gamma BHC.
3. 10 per cent. DDT dust + 0.7 per cent. gamma BHC.
4. 20 per cent. Toxaphene dust.
5. Untreated.
6. ICI Cotton dust: DDT 5 per cent.; BHC 3 per cent.; Sulphur 40 per cent.
7. 0.25 per cent. DDT Wettable powder + 0.008 per cent. gamma BHC.

Experiments 1 and 2 received six applications each between August 25th and October 5th, and August 29th and October 20th respectively. The third isolated experiment received five applications between September 7th and October 24th.

The rates of application varied with the sizes of the plants. The sprays were applied to give a thorough wetting of the plants with a slight run-off, and, on the earliest sowing, rates varied from 75—100 gallons per acre: on the later sowings, 60—65 gallons per acre were sufficient to give the same effective cover. Dust rates varied from 24—35 lb. per acre.

The rainfall during the period when treatments were applied totalled 5.9 inches, and all fell on 10 days between August 25th and September 30th. On the average there were two days between successive applications on which rain fell. While these are not severe conditions, the rain showers were sufficiently heavy to remove all the dust treatments.

The yields of Grade 1 seed cotton in pounds per acre harvested from the different treatments are given in the following table:

TABLE 4.
INSECTICIDE TRIALS, DAUDAWA, 1949.
Yields in lb. per acre.

<i>Treatments.</i>	<i>Experiments.</i>		
	1	2	3
1	*489	*463	491
2	*450	339	451
3	354	293	438
4	348	*379	428
5	321	288	420
6	—	—	368
7	—	—	425
SE ±	39	27	43

The significant increases in yield occurred only in the first two experiments, where the general level of attack was high, and the best increases in yield were obtained with the two spray treatments. Toxaphene dust gave a significant but poor increase. The results from experiment 3 appear anomalous at first, since it was sown later, i.e., 25 days after experiment 1, and yet shows the higher yields throughout. If table 5 is consulted, however, it is seen that the bollworm attack on the untreated plots of the earliest plot (expt. 1) was about six times that on the 9th July plot (expt. 3), and this heavy bollworm attack counteracted any greater yield that might have been expected from expt. 1, due to its earlier sowing: The best treatments (1 and 2) on the earliest sowing produced only the same yields as could be expected from a later sowing where losses due to bollworm were low and unaffected by treatments. With the treatments so far tried, and under conditions in which a heavy early attack can be expected, there appears to be no advantage in sowing as early as mid-June. It remains to be seen however, what results could be achieved if the main block (as in experiment 3) were all sown in mid-June with no

succession of sowings to build up an early attack of bollworms and stainers. It is clear, also, that had the treatments in experiments 1 and 2 been more effective in controlling bollworm damage, higher yields could have been expected. The comparatively poor control achieved here was probably due to the effect of rain, and the fact that the applications ceased too soon and the second wave of attack by Red bollworm in November was not controlled. In the two adjacent experiments stainer damage accounted for as much loss in yield as bollworm damage, and in experiment 1 this damage was significantly reduced by treatments 1 and 4.

An examination of bollworms occurring in crop samples throughout the season showed that in all three experiments *Diparopsis* was the dominant species, then *Argyroplote*, and *Platyedra* and *Earias* least numerous and of equal status. An analysis of the numbers of the different species occurring in the samples showed that none of the treatments significantly reduced *Diparopsis*, but in experiment 1, all treatments significantly reduced numbers of *Argyroplote*. In spite of this apparent lack of control of the dominant species (*Diparopsis*) and of "total bollworms," there were significant increases in yield associated with significant reductions in bollworm damage.

This reduction in damage was apparent in both the shed and un-shed material. Examination of shed buds and bolls revealed that, while no treatments had any effect on the total amount of shedding (and hence on the number of bolls set per plant), in experiments 1 and 2 there were significant reductions in bollworm damage to the shed material. This confirms previous conclusions that shedding was independent of bollworm damage, since reducing the attack on shed material produced no reduction in the total shedding.

The better treatments gave highly significant reductions in attack on the non-shedding bolls with consequent increases in proportion of clean cotton, and this control alone appears to be responsible for the increases in yield. The analyses of lock-damage in non-shedding bolls are shown in Table 5.

TABLE 5.
INSECTICIDE TRIALS, DAUDAWA, 1949.
Lock analyses in non-shedding bolls.

Treatment.	Experiments.					
	1—Sown 14th June.		2—Sown 12th July.		3—Sown 9th July and isolated from 1 and 2.	
	% Clean.	% BW	% clean.	% BW	% clean.	%BW
1	*66.07	*10.12	*72.94	* 9.43	87.65	5.78
2	60.01	13.59	60.21	13.34	87.88	6.53
3	50.93	19.97	53.56	19.21	90.03	4.95
4	51.34	22.71	68.39	14.88	88.60	5.78
5	43.70	20.97	59.66	18.79	91.25	3.58
6	—	—	—	—	88.05	5.60
7	—	—	—	—	85.65	7.73
SE ± ...	3.1	2.1	4.1	1.9	2.9	1.4

These contradictory results suggest that either the samples for bollworm counts were too small and hence inaccurate, or that the insecticides did not immediately kill the *Diparopsis* larvae, which were then able to enter the bolls. It is however surprising to find that the only bollworm apparently controlled was *Argyroplote*: the eggs of this species are laid on the green bolls and the larvae would be less likely to come into contact with the insecticide deposit than those of *Diparopsis*. The identity of all larvae was carefully checked by examination under a binocular microscope and confusion of species can be ruled out. It may be that the effect of DDT and gammexane on Red bollworm is not to give an immediate kill but, in the first place, to reduce or interfere with their feeding activity, so that no immediate drop in numbers would occur but the damage would be reduced. This sort of effect has been demonstrated after the treatment of cereal crops for the control of wire worms, and hence is not an impossible explanation.

There remains the possibility that partial elimination of predators was responsible for lack of control of Red bollworm: a partial kill of predators and Red bollworm would produce the results shown. It is possible, but cannot be proved from our records, that the control of *Argyroplote* alone resulted in the increased yields and reduction of bollworm damage.

It is clear that further trials will be required before any definite answer can be given to the question of controlling Red bollworm. Future trials will be repeated under conditions similar to those of this season, but on the main multiplication scheme first applications will be delayed until the October activity of *Diparopsis* commences, and will be continued to give protection against the November attack. The number of applications made will be determined by the rainfall.

PROGRAMME FOR 1950-51.

The results from the past season have again confirmed that bollworms are responsible only for direct damage to the crop, and do not cause heavy boll-shedding. The moth-flight studies of *Diparopsis* have pointed to the benefits of a thorough close-season, and date of sowing trials will be laid down in the coming season at Samaru and Daudawa to follow the pattern of crop production and loss in relation to the cycle of Red bollworm activity. The sowing dates will range from mid-June to late July or early August. In the remaining areas studies of populations of, and damage by, bollworms and stainers will be continued: this will include moth-flight studies of *Diparopsis*.

The insecticides trials will be repeated at Daudawa. The treatments to be tested are high and low volumes per acre of DDT and BHC at low and high concentrations respectively. The dust for cotton produced by ICI will also be tested again.

WEST INDIES.

COTTON EXPERIMENT STATIONS.

INTRODUCTORY NOTE

BY

J. V. LOCHRIE.

CROP CALENDAR :

	<i>Antigua.</i>	<i>Montserrat.</i>	<i>St. Vincent.</i>
Close season	1st June—31st August	1st December—28th February.	1st May—14th August.
Planting periods :			
Main crop	Sept.—Oct.	1st March—31st April.	15th Aug.—30th Sept.
Expt. Stations	1st—7th Sept.	4th March	14th—16th Sept.
Reaping Period :			
Main crop	Feb.—May	July—Sept.	Dec.—Feb.
Expt. Stations	23rd Jan.—25th April.	7th July—19th August.	Jan.—March.
Rainfall :			
12 months	50·34"	—	—
Cropping Period	(8 months) 39·61"	(7 months) 54·56"	(8 months) 56·33"

COMMERCIAL CROP.

The Superfine Sea Island crop, over 90 per cent. being the V135 variety in St. Vincent, maintained its acreage of around 3,500 acres, of which two thirds were grown by peasants. Production was higher owing to an increase in yield from 105 lb. to 132 lb. of clean lint per acre.

Cotton stainers and Pink bollworm were more in evidence than usual and increased the proportion of stained cotton.

The St. Vincent cotton acreage from year to year is influenced by the price offered, as the crop competes to some extent with arrowroot and groundnuts. The prospects for the coming season are promising, and there is an increasing demand for fertilisers as a result of the recommendations made possible by the experimental work of the Department of Agriculture.

The MSI variety comprises over 75 per cent. of the Sea Island crop and is produced under two different planting seasons, Antigua and Nevis planting in September–October, and Montserrat and St. Kitts in March–April. The area this season was 10,000 acres, a drop of 2,000 from the previous year. This is accounted for by the very low planting of 1,000 acres in Nevis. Antigua was again the largest producer and gave the highest yield—212 lb. per acre, of which 93 per cent. was clean lint. Owing to the lower Pink bollworm attack

and to the better treatment given to the much reduced acreage, the position in Nevis improved with a yield of 126 lb. clean lint per acre compared with just half that in the previous year. The Montserrat crop was planted early and reaped before the heavy September rains. The average yield of 154 lb. per acre was less than that of the previous season, owing to shedding in a dry spell in mid-season and to heavier attacks of Pink bollworm.

EXPERIMENT STATIONS.

On the Antigua Station climatic conditions were reasonably good but yields were reduced by an unusually heavy aphid attack.

The results of manurial trials followed the same general pattern as in previous years. Potash is not a factor on these soils but excellent results follow the use of pen manure, and consistent, if not spectacular, yield increases are obtained from superphosphate. In both cases the evidence is in favour of relatively low rates of application.

Useful information is accumulating on land use ; the growing of maize in the close season depresses the yield of the following cotton crop, and weed fallow or even a green manure crop also adversely affects cotton unless the cover is ploughed under early and nitrogenous fertiliser added to the buried residues.

In the rotation trials it is clear that the yield of forage from elephant grass falls off rapidly from year to year unless heavily dressed with nitrogenous manures. In breaking up grass-land, ploughing must be early to allow a considerable period of bare fallow if satisfactory cotton crops are to be obtained.

From investigations on the differences in quality of MSI cotton it appears that the major factor in spinning value is the period of the year in which the crop is grown. As a result of the lower quality of MSI in islands planting in September the question of a change to a higher quality variety is under consideration. To meet this the programme of plant selection and strain testing has been expanded.

On the Montserrat Station the work of maintenance of the MSI variety and of supplying pedigree seed for multiplication in other islands continued as usual. Early rains were good and the crop was established early.

As in Antigua, potash is not a limiting factor and fertiliser work is concerned with nitrogen and phosphate. Owing principally to some aphid attack the results were not at all conclusive this season.

Results from the combined fallow and pen manure trial followed similar lines to those of the work in Antigua. Bare fallow in the cotton close season gave better results than weed fallow, and in both treatments the yield increases from small applications of pen manure were considerable.

On the Camden Park Station in St. Vincent the V135 selection and seed renewal scheme was carried out on the usual lines, and further work was done on the VH8 material. Strains have been isolated which are equal in spinning value to V135, and the stage has been reached when clarification is needed of the yield capacity and spinning value of the two cottons under the range of conditions found in ordinary commercial cultivation. Trials to this end are proposed for the coming season.

On the fertiliser side the trials gave further evidence of a considerable and widespread need for nitrogenous manures and it is encouraging to note that the use of such fertilisers is increasing. The trials have also indicated the need for phosphatic manuring on some of the soil types but potash increased the yield in only one trial.

COTTON EXPERIMENT STATION, ANTIGUA.

PROGRESS REPORT FOR THE SEASON 1949-50

BY

J. V. LOCHRIE AND J. R. SPENCE.

METEOROLOGY.

The monthly rainfall and temperature figures are tabulated : A. being the rainfall for the 1949-50 season, and B. the average over 30 years.

	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Total.
A ...	2.86	2.50	3.42	14.51	5.90	2.61	3.26	4.58	2.92	1.47	4.36	1.95	50.34
B ...	3.82	3.74	4.43	4.77	5.22	5.35	2.86	2.38	1.62	1.54	2.04	3.27	41.04
Mean Max.	84.6	85.5	86.6	84.9	83.8	83.1	81.3	78.8	79.3	80.4	81.2	82.6	82.7
Mean Min.	74.6	75.8	76.7	75.2	75.0	73.8	71.4	69.3	70.0	70.3	71.0	73.6	73.1

The rainfall for the year was 10 inches higher than in the previous season, the difference being accounted for almost entirely by the very heavy falls in early September. Distribution was fairly satisfactory, though the heavy rains at the beginning led to some delay in planting and no doubt caused considerable leaching of the soil nitrate accumulated during the close season. Ample rains, accompanied by much cloudy weather, followed through September and October, and unusually heavy aphid infestation coincided with this period and caused stunting of plants and loss of yield. November and December were on the dry side, but the crop carried over well, though the later build up of Pink bollworm prevented the crop from benefiting from the excellent January rains. The average yield on the Station was about 300 lb. lint per acre compared with the high figure of over 500 in the previous season. The factors contributing to this drop in yield were the aphid attack and the general slower growth.

AGRICULTURE.

Pen manure.—In the previous three seasons the trials compared three rates of application of pen manure with no manure and with artificials. The results have shown considerable and significant yield increases from pen manure and, further, that increasing the application over the lowest rate gave only slight additions of yield. In addition to the three cotton crops to which applications were given, crops of maize were grown in the close seasons in 1948 and 1949. The rainfall was low and the maize yields well below the usual run of crops in the wet season. There was no response to manures, and obviously moisture was the limiting factor, as the tendency was for growth to be smaller in the plots which had made bigger plants and yielded higher in the preceding cotton crop.

This season it was decided to investigate the residual effects of the manures, using both cotton and maize as indicator crops.

Treatments (applied over the 3 year period).

1. 9 tons Pen Manure.
2. 18 tons " "
3. 27 tons " "
4. Artificial with equivalent N : P : K : to treatment 2.
5. Unmanured.

The average equivalent per ton, from analysis, of the pen manure applied over the period was 124 lb. sulphate of ammonia, 82 lb. 20 per cent. superphosphate and 67 lb. sulphate of potash.

TABLE I.

TREAT- MENT.	COTTON.					MAIZE.			
	Growth.		Flowers.	Yield.		Growth.		Yield.	
	28 days %	50 days %	%	%	lb. s.c. per acre.	17 days %	35 days %	%	lb. gra n per acre.
1.	106.9	114.4	113.8	115.7	738	116.3	156.2	124.2	2,081
2.	114.2	145.5	126.5	137.6	878	132.0	206.5	129.9	2,176
3.	136.8	167.1	140.2	146.2	933	152.1	248.3	156.2	2,617
4.	111.3	123.9	130.7	121.9	778	132.5	171.8	125.5	2,102
5.	100.0	100.0	100.0	100.0	638	100.0	100.0	100.0	1,675
C.D. 5%	15.1	19.4	18.4	17.1	109	8.6	37.5	22.1	370

The results show the same trend as in the seasons of direct application of the manures, but the differences between rates are more pronounced. The plants in the higher pen manure series remained green longer and, but for the Pink bollworm infestation of the late bolls, the yield differences would have been still more pronounced. There are indications that the effects of the lower rates are diminishing while the treatment with artificials has improved its relative position. The effects on maize were similar and it appears worth while to continue the trial for a further season.

Phosphate placement.—In manurial trials in past seasons, superphosphate has been applied by broadcasting and working into the ridge before planting. In view of the possibilities of the "placement" method a trial was carried out to test small amounts placed—25 lb., 50 lb. and 100 lb. per acre—against one of 200 lb. broadcast along the ridge and hoed in. The "placed" superphosphate was put in hoed holes, covered with soil, and the seed planted. With the "placed" supers there were striking and significant delays in germination, the depression being in direct proportion to the amounts applied. Full stands were obtained later but early growth was affected and, in the case of the higher rates, yields were lowered.

A separate germination trial gave corroboration and stressed the need for care in fertiliser application. Placing the superphosphate say 2 inches under the seed is quite satisfactory under good moisture conditions but for the give and take of crop planting it is safer to apply the fertiliser some distance to the side as well as at some depth below the seed.

Nitrogen-phosphate.—The trial compared three rates of sulphate of ammonia—100 lb., 200 lb. and 300 lb. per acre—half applied at planting and half five weeks later, and two rates of superphosphate—150 lb. and 300 lb. per acre—in all combinations. The area was patchily affected by aphids. It is not proposed to stress the treatment differences found under the conditions but growth, flowering and, to a lesser extent, yield were increased by nitrogen and the increases followed the amounts of sulphate of ammonia applied. On this soil, increases from applied nitrogen have been rare in the past and it is considered that the present effects are due to leaching of soil nitrate by the heavy rains just before planting. The indications from phosphate fall into a familiar pattern here with an increase from the first increment only.

3×3×3 NPK experiment.—This trial has been carried out on the same site for the past two seasons and it was decided to investigate the residual effects of the two years' manuring. The earlier results from the trial have shown no effects of potash in growth or yield and this is in line with other trials and with the analyses of the soil. Similarly nitrogen gave no responses and this has been attributed to the build-up of soil nitrate in the cotton close season. As in all other trials involving phosphate, there have been large growth increases, with yield increases at a lower level but of a magnitude of 20 per cent. over unphosphated plots. No advantage has so far been found from rates of phosphate above the first.

The trial was on the section of the Station affected by aphids but the attack was more general. The layout consists of two replicates and sulphate of ammonia was applied to the N. plots in one replicate.

TABLE 2.

Treatment.	Y. Block. S. Amm. added.			W. Block. Residual effects.			
	Plant Growth Gms.		Yield S.C. lb. per acre.	Plant Growth.		Yield S.C. lb. per acre.	
	63 days.	77 days.		63 days.	77 days.		
N ₀	63·6	87·1	677	84·6	107·9	715	
N ₁	78·0	98·2	654	83·9	113·6	764	
N ₂	82·4	110·6	653	82·6	109·0	684	
Sig. Linear	1%	1%	N.S.	N.S.	N.S.	N.S.	
Sig. Curvature	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	
P ₀	67·2	88·2	580	70·7	93·2	598	
P ₁	79·6	102·1	711	91·8	118·0	738	
P ₂	77·2	105·6	693	88·8	119·3	826	
Sig. Linear	5%	1%	N.S.	5%	1%	5%	
Sig. Curvature	N.S.	N.S.	N.S.	5%	N.S.	N.S.	

The main features are :—

1. No indication of residual effects of potash or nitrogen.
2. A significant linear effect of N. where the sulphate of ammonia had been applied to this crop (Y Block). It is suggested that this is due to the leaching rains before planting. Why these growth increases were not reflected in yield needs clarification.
3. The linear responses of P. in growth were significant in both blocks but in yield the response reached significance only in the block with no added nitrogen.

LAND USE.

Rotation trial A.—The object is to investigate the effects on following cotton crops of :—

- (1) three crops of sugar cane—plant cane and two ratoons :
- (2) elephant grass for the same period—cut for forage :
- (3) continuous cotton broken with a complete year in a leguminous cover crop :
- (4) continuous cotton growing, as is common peasant practice.

The trial includes an unmanured series and one receiving a heavy dressing of superphosphate at the beginning of the trial and with sulphate of ammonia applied annually. The reasons for the choice of these rotations were given in the 1946-47 Report.

The test crops have now completed their period and the whole area will be planted to cotton, as the indicator crop, in the coming season. Productivity records have been kept during the course of the trial and are given.

TABLE 3.

Crop.	Yield in lb. per acre.				% increase from manuring (Total).
	1947-48	1948-49	1949-50	Total.	
Sugar Cane	37,207	36,045	37,952	111,204	Nil.
Grass (as cut)	90,901	52,503	29,236	172,640	21.5
Cotton—1	*764	2,033	967	3,764	18.0%
Cotton—2	*588	2,009	Rest Crop	2,957	

*The 1947-48 cotton was damaged by *Nezara*.

There was no effect of manuring on the yield of cane over the period but cotton and, more consistently, the grass showed significant increases.

A feature is the steady falling off in grass yield over the three year period—nearly 53 per cent. of the total being produced in the first season, 30 per cent. in the second and 17 per cent. in the third—though rainfall was better in the later years. In view of this progressive falling-off in yield the rate of sulphate of ammonia was raised from the normal 75 lb. to 300 lb. per acre at each of the last three cuttings on half of the manured plots. In these cuttings the normal 75 lb. rate gave an increase of 3,600 lb. per acre (17 per cent.) over the unmanured while the high rate of sulphate of ammonia gave an increase of 15,400 lb. (73 per cent.).

It is clear that a high productivity of elephant grass cannot be maintained here without resorting to high nitrogenous manuring. A final assessment must await the results on succeeding arable crops as well as the forage produced. Other grass species are under observation and the solution may lie with a less demanding grass or mixture of grass and legume—if a suitable one can be found.

Grass fallow.—In view of the very poor performance of arable crops planted soon after the breaking-up of grassland, attention has been given to the problem of returning grassland to annual cropping. A trial was carried out last season and it was decided to lay down a second on similar lines this year.

In the present trial the elephant grass was cut and removed and at the ploughing of each series the stools were removed. The treatments were as follows :—

- (1) Ploughed in April and bare fallow until cotton planting in September.
- (2) Ploughed „ July „ „ „ „ „ „ „ „ „
- (3) Ploughed late August and cotton planted soon after.

TABLE 4.
SUMMARY OF DATA.

Treatment.	Germination.	Growth.		Flowers.	Yield.
		28 days. %	63 days. %	%	%
(1) ...	160.7	146.7	271.5	140.1	140.1
(2) ...	142.7	125.4	156.1	110.1	113.9
(3) ...	100.0	100.0	100.0	100.0	100.0
C.D. at 5% ...	15.4	17.1	51.8	12.2	22.0

The results confirm those of last year, though the differences in the later stages of growth and in yield are less pronounced. ~ This is most likely due to the higher rainfall in the early part of the season and the correspondingly quicker breakdown of plant residues. It is clear that this grassland should be ploughed up well in advance of crop planting, and results from the ploughing-under of a close season growth of weeds indicate that the application of sulphate of ammonia to the grass residues at the time of ploughing can offset to some extent the ill effects of delayed ploughing-under of plant residues.

Rotation B.—This trial was continued for the third season, the objects being to investigate the effects of various close season treatments.

- (1) a close season food crop—maize.
- (2) a short-term leguminous green manure crop.
- (3) a weed cover as is common in peasant practice.
- (4) bare fallow in the close season.

There is an unmanured series and one receiving a dressing of superphosphate at the beginning of the trials and an annual application of sulphate of ammonia. In the first year the nitrogen was applied to the cotton crop in all crop treatments but the poor and delayed growth and low yields following weeds and green manure suggested that the available nitrate was locked up in the decomposition of the plant residues in the critical early part of the cotton season. As a result, in the succeeding years, the sulphate of ammonia was applied to these two treatments when the residues were ploughed in, and to the others in two doses—half at thinning and half two weeks later.

TABLE 5.

Close season treatments.	Growth.		Flowers.	Yield.	
	25 days. %	77 days. %	%	%	lb. per acre.
(1)	100.0	96.2	87.6	83.7	734
(2)	110.0	119.8	101.1	104.4	916
(3)	100.0	100.0	100.0	100.0	878
(4)	108.0	110.0	101.2	105.4	925
C.D. at 5% ...	N.S.	14.7	N.S.	15.4	135.1
Level of Sign. ...	N.S.	5%	1%	5%	5%

In yields the positions of bare fallow, green manure and weed fallow are the same as last year but the early superiority of the former in growth is substantially less this season owing, it is considered, to the more rapid decomposition of plant residues in the high rainfall. It is clear from these trials that the ploughing under of a cover, particularly of weeds, at the end of the close season adversely affects the growth and yield of a following cotton crop unless a fairly heavy application of nitrogenous fertiliser is added to the residues at the time of ploughing.

The bad effect of growing maize in the close season is becoming more pronounced and the adoption of the practice will depend on the value the grower places on the maize crop to offset the loss of cotton yield.

Land rehabilitation.—The investigation started some years ago on eroded and exhausted hill slopes is being continued. The soils are similar to those of the valleys but much shallower, and the lines of investigation include trials of methods of soil and water conservation, of various crops and rotations, and of the effects of manures.

Conservation measures are clearly needed, but it is now apparent that bench terracing is not practical where arable cropping is intended. The narrow benches hamper all operations and the competition of the grass holding the bench slopes reduces crop returns. Cotton appears to derive some benefit from the shelter of the grass but sugar cane particularly is seriously affected. Contour ridging at less frequent vertical intervals gives good protection to the soil and a better chance for the growing of crops but the planting ridges should be split at each cropping to prevent the terracing effect of moving the soil downhill in cultivation.

The rotations range from permanent grass through those including a grass ley to rotations of arable crops of cotton, sugar cane and maize. The indications are that, given adequate conservation measures, these hill slopes can be used productively; guinea grass grows well and reasonable arable crops can be obtained. Though shallow, the soils on analysis show good nutrient status and the most important point is probably to retain all possible moisture in them. So far the yield increases from manuring have been considerable but not spectacular.

COTTON QUALITY AND GRADE.

Grade.—The need for high standards of handling, including thorough drying of seed cotton and the removal of stained cotton and plant debris, are well understood and reasonably well practised by growers. In spite of this care, reports from the graders commonly refer to lack of lustre and loss of appearance accompanied by a drop in grade. The causes are rather difficult to trace but there is some evidence that peasant-produced cotton grades a little higher than that of estates. Following this indication a range of samples, collected and prepared on the Station, were submitted to the Raw Cotton Commission and the graders report revealed marked differences in lustre and appearance. Lint from seed cotton “whipped” on wire mesh trays during cleaning—the usual estate method—showed the greatest falling off. The results of the examination showed that cotton should be reaped as soon as possible; it should be dried with a minimum amount of exposure to the sun; it should be cleaned without “whipping” on wire trays; and storage in big, tight heaps should be avoided, especially before the seed cotton is thoroughly dry.

Quality investigation.—MSI cotton in Nevis and Antigua is of poorer quality with lower yarn strength and higher hairweight than that of Montserrat and St. Kitts. The same strain is grown and there is an annual seed renewal scheme from pedigree seed obtained from the Montserrat Breeding Station. It is thus clear that the differences in quality are due to environmental causes. Sampling in the crop within each island has shown that differences in soil type and fertility do not account for quality differences at all comparable with those found between the two groups of islands. It is significant that the “high quality” MSI islands plant the crop in March–April, while the “low quality” islands plant in September–October, and the present work is concerned with the examination of this environmental complex. Considerations of close season and pests—Pink bollworm—make it impossible to use outside plantings and recourse had to be made to “caged” plots.

*Spinning and Hair Test data.**Caged Plots, Antigua—Antigua and Montserrat Commercial samples for comparison.*

	Planting date.	E.L.	M.R.	H.M.	H.S.	C × S 80's counts.	Notes.
Antigua ...	{ October, 1947 ...	52	.785	131	167	2,260	Caged Plots.
	{ April, 1948 ...	56	.895	127	142	2,527	
	{ July, 1948 ...	55	.885	130	147	2,455	
	{ April, 1949 ...	56	.885	120	136	2,571	
Montserrat ...	April, 1948 ...	55	.900	129	144	2,500	Commercial crop. Crop samples.
Montserrat ...	April, 1949 ...	55	.990	141	142	2,434	
Antigua ...	Sept.–Oct., 1948 ...	54	.845	144	171	2,178	Mean 10 year crop samples.
Antigua ...	Sept.–Oct. ...	55.5	.850	136	161	—	

It is apparent from these tests that MSI cotton planted in April and July in Antigua produces lint as fine as and of equal yarn strength to the Montserrat crops. The season in Antigua from April onwards is dry and it was necessary to give additional water to the test plots from time to time.

Some preliminary observations have been made to determine the particular factor of the environmental complex and these are summarised :—

1. Comparisons of low and high soil moisture conditions show no effect on lint fineness or yarn strength.
2. No appreciable differences have been found between samples grown inside the cage or in the open at the same period. The wire gauze cage makes a considerable reduction in light and, on this and other evidence from meteorological records, it is suggested that light intensity is not a considerable factor.
3. Further evidence is being sought on the influence of temperature but present indications, coupled with the fact that the temperature range is small, are that the main cause of the difference in lint quality must be sought elsewhere.
4. Consideration of the results so far suggest that length of day may be the main factor—in the latitude of the islands concerned there is a difference of fully two hours, with the high quality islands making their crop in the long days, compared with the Antigua crop developed in the short day period. Investigations are proceeding along these lines but it is sad to record that the “caged” area was completely destroyed in the recent hurricane.

COTTON BREEDING.

The Type collection and variable bulks of Sea Island strains were maintained on the lines of previous years.

In the preceding section the lower quality of MSI grown in Antigua and Nevis was mentioned. On the evidence the problem might be answered by a change in the planting season but, on considerations of rainfall alone, any radical change in the planting season is out of the question particularly in the case of Antigua. Improvement in quality can only come from a change to a higher quality Sea Island variety and the programme of the Station has been adjusted so as to meet the need as quickly as possible should a change become urgent.

Information from earlier trials indicated that BD—one of the old ordinary St. Vincent types—might be suitable. In fibre characters and spinning value it is better than MSI but against this is some loss of ginning percentage and lint yield. Progeny row work has started and a seed multiplication scheme is in operation. In addition to BD, seed bulking and variety testing of a number of other Sea Island cottons is in progress.

TABLE 6.

	Antigua.				Nevis.			
Variety.	Lint. lb. per acre.	Ginning. %	Seed Wt. gms.	C × S 80's	Lint. lb. per acre.	Ginning. %	C × S 80's	
MSI ...	412 [†]	33.6	13.10	2,409	353	31.8	2,333	
V135 ...	—	—	—	2,865	217	25.5	2,794	
NSI ...	354	28.7	11.61	2,631	206	27.1	2,704	
BD ...	354	28.4	12.64	2,736	242	27.1	2,558	
VH10 ...	396	31.7	13.34	2,592	275	32.0	2,371	
VH8 ...	342	27.3	13.30	3,000	252	28.4	2,775	
C.D. 5%	39	—	—	—	26	—	—	

In the Antigua trial the VH8 was made up of six sub-strains. These were compared in a further trial and showed fairly considerable differences in yield, ginning percentages, and spinning value. Similarly three sub-strains of VH10 were compared but these showed a strong similarity in all characters measured.

The work is progressing and seed is available for an extensive scatter of variety trials from which information on spinning quality as well as agricultural suitability can be obtained. In addition, multiplication areas of some 10 acres or more of a few promising varieties will be grown and it is hoped that mill tests will be possible on the lint from these.

PESTS AND DISEASES.

Pests as usual took a toll of the crop but the feature this season was the rather heavy infestation of aphis.

Leafworm (Alabama argillacea) appeared early and there were heavy attacks. Spraying with lead arsenate was efficient and no damage occurred.

Aphis gossypii was unusually heavy in late September and October and caused pronounced stunting. The attack coincided with the cloudy weather in the early season and persisted into the sunny weather, when there was a rapid build up of predators. The pest was limited to a small area of the country where loss of yield was caused. On the Station the patchy nature of the infestation upset the reliability of some trials.

Heliothis sp. is fairly common on maize crops but seldom is the cause of much damage to cotton here. In the present season a greater loss of buds than usual was noticed.

Nezara viridula was not serious this season. It did not appear until December, and then only on cotton bordering on waste land—probably maintained on the good growth of alternate hosts such as legumes in waste land as a result of the good rains. During the close season *Nezara* was abundant in plots of legumes which are under observation as possible components of a grass-legume ley. The abundance of the pest suggests that attention would have to be given to control where such a mixed ley is considered.

Cotton stainers were again of no consequence, as the pest did not appear until late in the season, and then in small numbers.

Pink bollworm appeared in some numbers at the beginning of flowering but this ominous start was not followed by any heavy boll infestation, and indeed the early pickings were very clean. As usual, the pest built up rapidly towards the end of the season and destroyed the late bolls on better grown crops.

Insecticidal control is at present confined to the use of arsenicals against leafworm, and efficient control is obtained. There have been promising indications of control of other insect pests by newer insecticides and a considerable amount of attention will be given to trials in the coming season.

PROGRAMME FOR 1950-51.

The 1950-51 programme will continue along the same general lines as in the past. The fertiliser trials are being expanded to cover as much of the conditions of the commercial crop as is possible.

The land use trials will be carried on and an additional rotation experiment has been arranged.

Cotton selection work will be continued in view of the probability of a change to a higher quality cotton in some of the MSI Islands. In order to get early and full information on possible replacement strains, variety testing will be done as extensively as sites allow.

Investigations on cotton quality will continue.

Insecticide trials will be carried out on the Station and on an outside centre. In these a number of insecticides will be tested in the form of both dusts and sprays.

[Included by courtesy of the Government of the Leeward Islands.]

COTTON BREEDING STATION—MONTSERRAT. PROGRESS REPORT FOR THE YEAR 1949

BY

A. S. HARPER.

The Station continued to operate under the guidance of Mr. J. V. Lochrie, Cotton Officer, West Indies.

WEATHER CONDITIONS.

Rainfall in March was satisfactory and practically the whole of the island's crop was planted during this month. Germination was good. The plants suffered a setback from a dry spell towards the end of May and there was a small percentage of boll shedding. Good weather for the picking of the crop prevailed from July until, in September, very high precipitations of 7.19 inches on the 1st and 7.01 inches on the 20th brought the rainfall for that month to 19.30 inches, the highest on record since 1897. Rainfall in inches for the cropping period at the Cotton Breeding Station, Bethel, and Brades was as follows :—

		Mar.	April.	May	June	July	Aug.	Sept.	Totals.
Cotton Breeding Station	...	7.82	4.21	3.59	6.64	5.19	7.81	19.30	54.56
Bethel		5.18	3.95	2.08	4.01	5.08	6.03	14.54	40.87
Brades		7.85	2.35	3.73	3.45	5.73	3.92	18.02	45.05

Pink bollworm was present in patches throughout the island. It made its appearance earlier than usual, in the first picking of cotton in some fields. The island's total area planted to cotton was 3,825 acres, 378 acres more than in the previous year. The yield averaged 154 lb. clean lint per acre against last year's average of 184 lb.

COTTON BREEDING WORK.

Sixteen of the 1948 progenies were selected and from these plants were obtained for planting the twenty 1949 non-replicated progeny rows. The sixteen selected progenies were bulked in pairs giving eight bulks which were grown in the small bulks trial consisting of eight randomised blocks.

In this latter trial significant differences were obtained in lint index only. Bulk MB4901, descended from progeny M4208, maintained the high lint index characteristic of the progeny. Yield varied from 571 lb. to 602 lb. lint per acre. Differences in ginning out-turn and seed weight were small.

Data from this trial are given in the following table.

1948 Progenies.	Seed Weight 100 seeds.	Ginning Out-turn	Lint Index	Yield per acre
	gms.	%	gms.	lb. lint.
MB4901, M4801 and 02	13.37	32.30	6.37	572.85
MB4902, M4803 and 04	13.31	31.84	6.24	570.59
MB4903, M4807 and 08	13.02	32.40	6.28	603.49
MB4904, M4809 and 10	13.07	32.25	6.25	591.01
MB4905, M4811 and 12	13.06	32.15	6.16	584.20
MB4906, M4813 and 14	13.22	31.80	6.20	581.93
MB4907, M4815 and 16	13.07	32.05	6.16	601.22
MB4908, M4817 and 18	12.86	31.76	5.98	602.35
Mean	13.125	32.07	6.205	588.45
Significant Differences	N.S.	N.S.	@	N.S.
Coefficient of Variation	2.5	1.9	2.8	—

@ = Significant.
N.S. = Not Significant.

Spinning test values.—The correlation coefficients between ginning out-turn and standard hair weight, between ginning out-turn and strength of yarn and between lint index and strength of yarn over the past six years (1943 to 1948) have been calculated, and in only two cases was any significance obtained. In 1944 a positive correlation between ginning out-turn and standard hair weight, and in 1948 a negative correlation significant at 1% level between lint index and strength of yarn, were obtained.

Selection for 1950.—Samples from the progeny rows were sent to the Shirley Institute for small scale spinning tests in October and strength of yarn data were received in January. Based mainly on these data and on the hair tests data from the 1948 progenies, nine of the 1949 progenies will be selected for progeny work and further multiplication.

Multiplication of selected seed.—After planting the progeny rows and small bulks the rest of the selected seed was bulked and was sufficient to plant five acres to first multiplication cotton. Yield was very good, 460 lb. lint per acre. One hundred acres of second multiplication cotton were grown at Richmond Estate.

Distribution of seed to neighbouring Islands.—The following quantities of pedigree seed were shipped to the neighbouring islands during the year :—Antigua 149 lb., St. Kitts 156 lb., Nevis 301 lb.

In addition to these the following quantities of planting seed were supplied :—7,017 lb. to St. Lucia, 49,506 lb. to Nevis and 3,423 lb. to Antigua.

MANURIAL EXPERIMENTS.

Two of the NP manurial trials were repeated this year, that on the Fresh Ash Soil on Richmond Estate and that on Government Land Settlement area at Amersham. Manures were applied at the rates used in previous years, namely two levels of ammonium sulphate and superphosphate (200 lb. and 400 lb. per acre each), applied four weeks

after planting. In future trials the superphosphate will be applied before planting.

Fresh Ash soil.—Aphis attack in April and May did much to hamper the growth of the plants in small patches throughout the experiment. Yield of lint in lb. per acre was as follows :—

		P ₀	P ₁	P ₂	Mean
N ₀	...	354	413	373	380
N ₁	...	400	430	371	400
N ₂	...	350	428	377	385
Mean	...	368	424	374	388

Increases from added manures were small and not statistically significant. Plots manured with ammonium sulphate at the lower rate of application, 200 lb. an acre, gave an increase of 5% over plots not manured with ammonium sulphate. Plots manured with superphosphate applied at the same rate gave, for the first time in trials carried out each year for four consecutive years on this soil type in the same field, an increase of 15%.

Chemical analysis carried out at the Imperial College of Tropical Agriculture showed the soil from the control plots to contain 0.067% nitrogen and 231 p.p.m. P₂O₅, 60 p.p.m. P₂O₅ less than in previous years.

Brown Earth soil.—The experiment on this soil type at Amersham was planted on the 10th March, and response to nitrogenous manuring was reflected in the increased greenness of the leaves of the plants of the nitrogen-manured plots during growth. Yield of lint in lb. per acre was as follows :—

		P ₀	P ₁	P ₂	Mean
N ₀	...	182	210	199	197
N ₁	...	225	245	285	252
N ₂	...	238	237	246	240
Mean	...	215	231	243	230

The plots manured with ammonium sulphate at the lower rate gave an increase of 27% over plots not manured with ammonium sulphate. Plots manured with superphosphate at the lower rate gave an increase of 7% and, at the higher rate of 400 lb. an acre, an increase of 14% over plots not manured with superphosphate. Differences did not reach statistical significance.

Rotation trial.—The trial described in earlier reports was continued. The bare fallow plots (B) were cultivated in early January and the weed fallow plots (W) late in February. Pen manure, at the rate of 2 tons per acre, was applied to the PM subplots in February. Treatment differences were observed during growth, the cotton following bare fallow being better than that after weed fallow and the pen manured subplots generally better than the corresponding unmanured

subplots. The yield in lb. per acre of seed cotton was as follows.

	(B)	(W)	Mean
PM ...	914	763	839
Nil ...	747	617	682
Mean ...	831	690	761

(B)—cultivated and left clean during close season.

(W)—left in weed fallow during close season.

PM—2 tons pen manure per acre.

Nil—No manure.

The bare fallow plots gave an increase of 20% over the weed fallow plots and the pen manure treatment an increase of 23% over the unmanured plots. Treatments were not statistically significant.

The cane planted in April, 1948, was harvested in July. It yielded at the rate of 20 tons per acre. Soil samples were collected from the control subplots of the cane, as well as from similar subplots of the cotton and grass, and these were sent to Professor Hardy, C.B.E., of the Imperial College of Tropical Agriculture, for analysis. Analysis of the samples received indicates the soil to be "light sand," to have contents of nitrogen varying from 0.096 to 0.158 per cent., fairly high contents of phosphate (mean 63 p.p.m.) and medium low contents of potash (mean 92 p.p.m.).

The grass planted in April, 1948, was cut for the first time in October and then at intervals of three to four months. Pen manure was applied at the rate of two tons per acre to pen manured subplots in May, 1949. In the first cutting after application manured subplots gave 9% increase, and in the second cutting 8% increase over the unmanured subplots.

ACKNOWLEDGEMENTS.

Thanks are due to Mr. R. B. Allnutt, Director of Agriculture and to the Hon. W. E. Bassett, M.B.E., for many valuable suggestions and criticisms and to various other members of the Department of Agriculture and planters who assisted in the work.

PROGRAMME FOR 1950.

Breeding :—

1. The breeding and seed multiplication will be continued.
2. Variety trials of Sea Island cotton strains.

Field experiments :—

1. N.P. trials will be continued on the four major soil series.
2. The trial on Brown Earth soil at Amersham will be repeated on the same site without the addition of any manure to determine the residual effect of nitrogen and phosphate.
3. The seven year rotational trial at Amersham will be continued.
4. A $2 \times 2 \times 2$ factorial design mainly for comparing the effects of thorough and poor cultivation.
5. Observation plots on cropping after grass.

[Included by courtesy of the Government of the Windward Islands.]

CAMDEN PARK EXPERIMENT STATION, ST. VINCENT.

PROGRESS REPORT FOR THE SEASON 1949-50

BY

H. A. FRANCIS.

WEATHER CONDITIONS.

Weather conditions at planting were favourable and very good stands were obtained in experiments. Conditions during the reaping season, however, were somewhat unfavourable owing to an abnormally high rainfall which caused a high percentage of stained lint. Pink bollworm made too late an appearance to cause much damage.

Rainfall for the crop period at the Station is given in the table below.

	<i>Aug.</i>	<i>Sept.</i>	<i>Oct.</i>	<i>Nov.</i>	<i>Dec.</i>	<i>Jan.</i>	<i>Feb.</i>	<i>Mar.</i>	<i>Total.</i>
Inches ...	7.78	6.60	15.24	8.01	7.66	2.40	3.10	5.54	56.33
Total December to March (Reaping season) 18.70 inches.									

BREEDING PROGRAMME.

The breeding programme was similar to that of previous years, namely (a) the V135 seed renewal scheme, and (b) work with VH hybrid material.

V135 seed renewal scheme.—Sixteen progeny rows were grown from sixteen selected plants from the previous season. Selections were based on the combined results of local field performance and spinning tests carried out by the Shirley Institute.

The remaining selfed seed from the progeny rows was planted for further seed multiplication, giving a yield of 664 lb. of seed. The second stage multiplication planted at Diamond Estate gave a yield of 70,992 lb. of seed which was available for the Colony's planting supply for the 1950-51 crop.

Work with VH hybrid material.—In the main breeding trial twenty-four VH8 progenies were tested against a representative V135 progeny in a 3 (5 × 5) lattice square design. The V135 progeny used for comparison was V4825. Measurement of the usual yield and seed cotton characters revealed very small differences between the twenty-four VH8 progenies, all of which out-yielded the representative V135 progeny. These differences, however, did not attain the level required for significance. Family performances are summarised in Table 1.

TABLE 1.
SUMMARY OF DATA—VH TRIALS 1949-1950.

Strain.	Family.	Lint per plot.	Ginning Out-turn.	Bolling index.	Seed wt. 100 seeds	Seeds per boll.
VH4701	VH4803	Gms. 399	29.9	503	Gms. 13.3	13.9
VH4704	VH4806	321	29.8	356	13.5	14.9
VH4707	VH4810	386	29.3	516	13.4	13.9
	VH4811	347	29.4	487	13.7	13.2
	VH4812	417	29.4	576	13.5	12.9
Mean		384	29.4	526	13.5	13.3
VH4708	VH4814	358	28.9	504	13.3	12.9
	VH4815	382	29.1	480	13.2	14.6
Mean		372	29.0	491	13.2	13.9
Mean for all VH Progenies		387	29.3	499	13.4	13.7
V135		248	25.8	432	12.9	13.0

The results of the spinning tests on the material in the trial revealed that most of the samples gave somewhat similar results, and that many were at least equal in strength to the V135 control. A summary of results follows.

CORRECTED LEA COUNT $\times$ STRENGTH PRODUCTS

Mean of all VH progenies	...	...	...	...	...	2962
Commercial V135	...	...	...	...	...	2980
Strongest VH progeny	...	...	...	...	...	3144
Weakest " "	...	...	...	...	...	2669

The average VH8 strength fell a little below the V135 control but the VH8 samples were less neppy.

Small bulk trial.—In this trial selfed seed from families utilised in the current year's breeding work, including a V135 progeny, was tested in a 5×5 Latin square. Average lint yield per family and corrected lea count $\times$ strength products are given in Table 2.

TABLE 2.

Families.	Lint-lb. per acre.	Corrected C. $\times$ S. Product.
VH4701	226	3081
VH4704	260	3005
VH4707	207	3109
VH4708	210	3111
V135	210	3082

Yield differences are non-significant while yarn strengths are nearly alike. The results of the spinning tests on material used in the small bulk trial again showed that the V135 control gave the neppiest yarn.

MANURIAL TRIALS.

Last season's pilot experiment was extended to take the form of a $3 \times 3 \times 3$ factorial design. Table 3 gives the treatments and mean yields of lint per acre.

TABLE 3.

TABLE 5.

(a) <i>Kind of nitrogen.</i>									
(1)	Sulphate of ammonia	...	...	...	...	...	...	...	361 lb.
(2)	Cotton seed meal	...	...	...	...	...	...	...	332 lb.
(3)	Coconut meal	...	...	...	...	...	...	...	339 lb.
(b) <i>Quantity of nitrogen.</i>									
(1)	60 lb. per acre as 300 lb. sulphate of ammonia						...	...	310!
	or 900 lb. cotton seed meal						...	...	
	or 1,200 lb. coconut meal						...	...	
(2)	100 lb. per acre as 500 lb. 1500 or 2000 lb. of above manures						...	...	358 lb.
(3)	140 lb. per acre as 700 lb. 2100 or 2800 lb. of above manures						...	...	364 lb.
(c) <i>Time of application.</i>									
(1)	Applied prior to or at planting	...	...	...	...	...	...	...	344 lb.
(2)	Applied to the growing crop	...	...	...	...	...	...	...	339 lb.
(3)	One half before and one half after planting	...	...	...	...	...	...	...	349 lb.

Observations made on the growth of individual plots confirmed that, taken as a whole, the plots treated with sulphate of ammonia made more rapid growth during the earlier stages and exhibited more vigour. This difference in appearance was maintained up to the middle and later stages of growth, when it became less outstanding, and provided an arbitrary assessment of the rate of availability of nitrogen as supplied by the three different fertilisers.

Although the analysis of variance revealed no significant differences the above data show a tendency towards increases in yield when nitrogen is supplied as sulphate of ammonia, and when the higher dressings of nitrogen are applied.

District NPK manurial trials.—Manurial trials were laid down in order to investigate the responses to N, P, and K on the different soil types throughout the Island. The following soil types were included.

	<i>Types.</i>						<i>Sites.</i>
Recent Volcanic Ash	...	...	...	...	...	...	Richmond.
Yellow Earth-High Level	...	...	...	...	...	...	Wallilabou.
Yellow Earth-Low Level	...	...	...	...	...	...	Cane Hail.
Coastal Valley or Dune	...	...	...	...	...	...	Diamond.
Alluvium...	...	...	...	...	...	...	Pembroke.

The layout of all trials was similar and took the form of a $3 \times 3 \times 3$ factorial design, 27 plots each of 1/100th of an acre.

The treatments used were sulphate of ammonia (N) and superphosphate (P) at nil, 400 lb. and 800 lb. per acre, and muriate of potash (K) at nil, 200 lb. and 400 lb. per acre.

The actual sites chosen were considered representative of the respective soil types and, apart from the application of experimental manures, all cultural treatments in the fields were in accordance with the usual local estate practices.

Performances on the various soil types are discussed individually below.

Recent Volcanic Ash—Richmond.—Statistical analysis of data revealed that the linear responses due to nitrogen and phosphate were significant, while that due to potash was not. Potash nevertheless accounted for a slight yield increase. In the case of nitrogen, the single and double treatments were both significantly superior to the

control, whilst the difference between them was non-significant. In the case of phosphate, the double dressing was significantly more than the control, while the differences between control and single and between single and double did not reach the significant level.

Mean Yields of Plots receiving N, P. & K. (lb. seed cotton per acre).

	0	1	2
Nitrogen	756	1,122	1,167
Phosphate	744	1,011	1,289
Potash... ..	933	1,067	1,044

Linear Significant Difference 394.

There was no significance of interactions

Yellow Earth—High Level—Wallilabou.—The treatment yields obtained in this trial are shown below.

Mean Yields of Plots due to N, P. & K. in lb. seed cotton per acre.

	0	1	2
N.	1,456	1,544	1,344
P.	1,367	1,422	1,556
K.	1,389	1,433	1,522

Linear Significant Difference 117.

In the case of nitrogen the linear response was not significant but the double dose produced a significant depression.

The linear responses to phosphate and potash were significant.

The only significant interaction was that between nitrogen and potash. The effect of potash in the presence of nitrogen was to increase yield by 233 lb. per acre.

The response to potash on this soil type is deserving of further investigation and is in conformity with a chemical analysis of a soil sample taken from the experimental site, carried out at the Imperial College of Tropical Agriculture during the year under review. This showed a deficiency in available potash—92 p.p.m. available K_2O .

Yellow Earth—Low Level—Cane Hall.—Statistical analysis of data revealed no manurial effects of significance. Yield responses due to fertilisers are nevertheless listed below :—

Mean Yields of Plots in lb. seed cotton per acre.

	0	1	2
Nitrogen	1,067	1,633	1,311
Phosphate	1,239	1,411	1,361
Potash... ..	961	1,478	1,572

Coastal Valley or Dune—Diamond.—In this trial, significant linear responses were obtained with nitrogen and phosphate. The result of a chemical soil analysis was once more confirmed in respect of this site :—Total nitrogen—0.92%, Available P_2O_5 —19 p.p.m.—Deficiencies. Responses due to potash were non-significant.

	0	1	2
Nitrogen	1,639	1,956	2,071
Phosphate	1,693	1,980	1,993
Potash... ..	1,799	1,944	1,923

Linear Significant Difference 225.

Responses due to both nitrogen and phosphate were similar in that both single and double dressings were significantly better than controls, while differences between single and double did not attain significant levels. There were no significant interactions.

Alluvium—Pembroke.—No manurial effects of significance were obtained in this trial, several plots in the trial suffering a loss of plants owing to wilt.

PROGRAMME FOR 1950-51.

Breeding :

- (1) V135 Progeny row non-replicated trial.
- (2) V135 1st stage commercial seed multiplication.
- (3) VH8 Main breeding trial.
- (4) VH8 Progeny rows.
- (5) VH8 Small bulk trial.

Field experiments :

- (1) Organic versus inorganic manurial trial to assess residual effects.
 - (2) District N.P.K. manurial trials to be continued with commercial V135.
 - (3) VH8 versus V135 district manurial trial.
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[Included by courtesy of the Queensland Government.]

QUEENSLAND.

REGIONAL EXPERIMENTAL STATION, BILOELA. PROGRESS REPORT FOR THE SEASON 1949-50.

BY

R. W. PETERS.

INTRODUCTION.

During the year Mr. W. A. R. Cowdry, who had been Manager of the Station since 1941, was transferred as Manager to the new Regional Experiment Station at Ayr in the Burdekin River Valley in North Queensland. Mr. J. G. J. Stevens, who had been Assistant Manager at the Hermitage Regional Experiment Station, replaced Mr. Cowdry at Biloea.

The progress report on the cotton investigations conducted at this Experiment Station during the 1949-1950 season has been prepared from the reports submitted by Messrs. J. G. J. Stevens, R. W. George and W. H. Cairns.

Following a dry autumn and winter, just under 6 inches of rain were received in October on 13 wet days. The rainfall for the rest of the season, with the exception of December and the first half of January, was also in relatively large rain groups, and consequently the season's rainfall was much more effective than equivalent total rainfalls have been in the past. However, the absence of any really good falls in December and early January caused considerable checking of growth to cotton and other summer crops, this check being more severe owing to the excellent growing conditions prevailing until December. Continuous wet conditions which occurred from the first week of February until April were responsible for excessive vegetative growth and considerable rotting of the early matured bolls. Frequent autumn rains also caused harvesting delays, further boll rots and lowering of the quality and yields of cotton.

Table I presents the more pertinent data for the season :—

TABLE I.

<i>Crop.</i>	<i>Planting Dates.</i>	<i>Picking Dates.</i>	<i>Legal Close Season.</i>	<i>Rainfall</i> 1.7.49-30.6.50.	<i>Mean Temperature</i> October to November.	<i>Mean Yield</i> <i>Lint</i> <i>per acre.</i>
Rain Grown Cotton ...	October 19-21	April to July	Nil	33.61 inches	Max. 84.8° F. Min. 59.4° F.	238 lb. on 16.7 acres.
Irrigated Cotton ...	October 18-20	April to August	Nil	33.61 inches and 1 to 3 applications of 3 inches each p.a.	Max. 84.8° F. Min. 59.4° F.	487 lb. on 14.9 acres.

METEOROLOGY.

The total amount of rainfall received during the twelve months ending 30th June, 1950, was 33·61 inches—5·56 inches more than the 26 year mean of 28·06 inches. This seasonal total was received in 93 wet days compared with the previous mean of 75 wet days. The monthly rainfall during the crop season, with the exception of December and January, exceeded the monthly means for the Experiment Station. The total amount of erosive rainfall (greater than 40 points per hour) for the 12 months approximated to the mean of past seasons, although the actual percentage of this class of rainfall to the season's total was somewhat below normal owing to the higher than average total rainfall received for the year. The minimum temperatures were somewhat below average for July and August but were approximately normal for September to December. Many wet and cloudy days were responsible for the below-average maximum temperatures during the growing period with the exception of December and January. Only two frosts were recorded in 1950 up to June 30th as compared with a mean of 7·3 frosts for the April-June period.

Relative humidity at 9 a.m. for the first half of the season except October was approximately average, but from February to June the humidity was considerably above average.

AGRICULTURAL PRACTICES.

The irregular distribution of rainfall over the growing season was not conducive to uniform development of the cotton crops. Early growth was rapid, and the plants tended to make rank growth associated with shallow rooting systems. During the dry period ruling through December and January the shallow-rooted, heavily-foliaged plants reacted severely when stress conditions were experienced and some square shedding resulted, in the early planted cotton particularly. Continuous wet conditions from late February onwards stimulated further excessive growth and a severe jassid attack subsequently developed. Hand picking commenced on the 20th March and continued as late as August; shortages of casual labour and delays due to wet weather were responsible for the most protracted harvesting period that has been experienced.

Mechanical Harvesting.—The new International Harvester Co. mechanical picker was used for harvesting operations during May, but efficient picking was seriously hampered by the excessively vegetative state of the plants. From the results obtained it was calculated that the machine harvested 73 per cent. of the crop. Harvesting of the top crop was not attempted with the machine because of the size of the plants and the fact that repeated rains softened the cotton burs to such an extent that it was impossible to harvest mechanically without including a high percentage of broken burs in the cotton.

IRRIGATION INVESTIGATIONS.

Time and Rate of Spray Irrigation Experiment.—This experiment was planted in the form of a 6 × 4 randomised block on October 19th.

Subsoil moisture was at field capacity to a depth of 38 inches in the plots which received a preplanting watering, compared with 28 inches in the non-irrigated areas which did not receive this watering.

Nitrate determinations taken in late December showed no significant differences between the amounts of nitrate present in any of the treatments, presumably owing to leaching during the heavy late November rain group. During late March the bolls throughout the area were opening well, but from then until late April the rank late growth was heavily attacked by jassids (*Empoasca maculata* Er.). The treatment which received a three-inch irrigation in September (as a preplanting watering) followed by a similar irrigation in November and December, produced the highest yield of 504 lb. of lint per acre, compared with 435 lb. in the treatment which received only one 3-inch watering in late December. The results confirmed previous findings that a supplementary irrigation when the plants are 5–8 inches tall promotes earlier fruiting and increases the chances of obtaining satisfactory yields, compared with delaying this irrigation until the plants are 15–18 inches tall in mid-December.

Irrigation and Rotation Experiment.—This 5×4 randomised block type experiment was planted in mid-October without any pre-planting irrigation, as the soil was wet to field capacity to a depth of 32 to 39 inches. By late January the soil moisture at all depths in the non-irrigated plots had been reduced almost to wilting point, whereas the irrigated plots which had received a 3-inch application early in January did not exhibit any pronounced stress conditions. These plots were in need of water, however, when the rain group of February commenced. The semi-flood rains in February and early March ensured ample supplies of moisture during the remainder of the season and no further irrigations were required.

The yields are presented in Table II. There were no significant differences between treatments for the first or final pickings, but in the second picking the plots following non-irrigated sorghum outyielded the other treatments by a highly significant amount.

TABLE II.

Treatment.	Seed Cotton in lb. per acre.		
	First Picking.	Second Picking.	Total.
A. Irrigated cotton following 3 years of irrigated Rhodes Grass ...	887	333	1,220
B. " " " " " sorghum... ..	988	362	1,350
C. " " " " " cotton	890	402	1,292
D. Non-irrigated cotton following non-irrigated Rhodes Grass ...	922	353	1,275
S. " " " " " sorghum	832	549	1,381

The order of yields reflected the comparative heights of the plants. The tallest plants gave the highest yields, which in turn were correlated with the nitrate status of the soil, the plots following non-irrigated sorghum having the greatest amount of nitrates although in all treatments the seasonal readings were lower than normal for this area.

VARIETAL TRIAL.

The site of this 6×4 randomized block experiment was new cultivation out of virgin grassland with soil moisture at field capacity to a depth of 38 inches when it was planted on October 18th. Growth was satisfactory until mid-January, when the plants were supporting a very fair crop of large bolls and a medium crop of squares. During early January there was such a heavy demand on the irrigation plant that the watering of this area was unavoidably delayed a few days too long, with a resultant check in growth. Following irrigation the plants shed many squares and when the February rains occurred a rank growth developed which was later attacked by jassids. This attack caused a severe setback to the plants and greatly reduced the number and size of bolls in the late middle crop and prevented the setting of a top crop. The heavy vegetative growth also prevented the cotton from drying out, and many bolls were lost through boll rots. Stoneville 2B, which produced the highest yield (461 lb. lint per acre), had the most suitable plant structure for mechanical harvesting.

SOIL INVESTIGATIONS.

Following a very dry winter, all the areas which had been cropped late in the previous season were dry and as a consequence the October rainfall (totalling 5.94 inches) penetrated only to an average depth of slightly less than 24 inches. Where crops had been either harvested close to the wet season or frosted in May in the 1949-50 season, the conserved subsoil moisture provided better conditions for penetration of the October rains, which reached the 36 inch zone in such areas. The heavy groups of rainfall experienced during the season tended to minimize the differential effects of rotations in relation to penetration of individual storms although there was a slight tendency for better penetration in cotton following Rhodes Grass. The penetration in grassland was much superior, however, to that in any of the cultivations.

The heavy early summer rains caused a general depressive effect on the nitrate content of all areas until hot dry conditions prevailed in late December, when readings in the older cultivations of rain-grown cotton reached more normal levels. Once more, evidence was obtained that cotton following newly broken up virgin grassland can experience a shortage of nitrates if continued leaching conditions prevail during the early growth of the crop.

Studies in the effect of cultivation and croppings on the size of water stable aggregates confirmed previous findings that cultural operations cause an increase in the amount of aggregates which can pass through a $\frac{1}{4}$ inch mesh when sieved under water. Evidence indicated that rotations embracing cotton, wheat and sorghum caused substantially less reduction of size of aggregates than did nine years of successive cropping to cotton. A marked restoration of aggregate size, more particularly the .5 mm. class, was effected in the 0-6 inch zone by three years establishment of Rhodes Grass.

COTTON BREEDING.

Plant selection work was carried out in the four most promising strains of jassid resistant Miller backcross cottons. Seven progeny increases were retained for multiplication and testing and many new selections were taken for further examination in the progeny plot next season.

In spite of a heavy jassid infestation over the whole Station these strains showed almost complete immunity and produced, under rain-grown conditions, an average per acre of 1,020 lb. seed cotton of excellent quality.

ENTOMOLOGY.

Investigations on the control of Corn ear worm *Heliothis armigera*, Hbn. were continued, the experiment incorporating a comparison of E.605, DDT and a combination of the two. The treatments and yields are shown in Table III.

TABLE III.

			First Picking.	Total (3 Pickings).
A.	Control ...	...	648 lb. s/c.	1,473 lb. s/c. p.a.
B.	0.4% DDT spray ...	...	1,094 " "	1,713 " " "
C.	0.015% E605 ...	...	954 " "	1,648 " " "
D.	0.2% DDT and 0.0075% E605	...	1,048 " "	1,598 " " "

Insecticides were applied when egg counts showed the presence of more than 15 *Heliothis* eggs per 100 plant terminals at any one brood.

Egg counts taken on December 14th revealed the presence of an average of 16 *Heliothis* eggs per 100 terminals and B, C and D treatment plots were sprayed at the rate of 36.2 gallons per acre. Data obtained in egg counts on January 3rd suggested that a slight decline in the *Heliothis* infestation had occurred during the early flowering period, but by January 9th the number of eggs had increased sufficiently to necessitate a further spraying at the rate of 48 gallons per acre. A square count on January 11th showed that the control plots were carrying the most damaged squares, and those sprayed with a combination of 0.2 per cent. DDT and 0.0075 per cent. E.605 the least number. A further square count at the end of January revealed no significant differences between treatments. Flower counts during January showed that all spray treatments were exceeding the control plots, and this was reflected in the yields obtained in the first picking compared with the total yield for the season. Apparently, sufficient control was obtained by the two sprayings to result in a satisfactory increase in yield.

PROGRAMME FOR 1950-51.

The programme for 1950-51 embraces the following investigations :—

Plant Breeding.—Multiplication of the most promising strains of jassid-resistant hybrids, the examination of the newer progenies and selections and the comparison of the more advanced strains with standard varieties under irrigation conditions.

Agronomic experiments.—A continuation of the general programme planted in the 1949–50 season with amplifications resulting from the findings of that season.

New work will include—

- (a) A modification of the time and rate of spray irrigation experiment, to embrace the three leading treatments and control, on second year cultivation out of virgin grassland, to test the merits of these treatments under low nitrate conditions.
- (b) Mechanical harvesting of a range of varieties grown with and without supplementary irrigation.
- (c) Continuation of the irrigation rotation experiment combined with a cotton varietal trial.

Entomology.—Amplification of 1949–50 investigations into the merits of various sprays for the control of *Heliothis armigera* Hbn. in irrigated and non-irrigated cotton.

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(at 31st March, 1951)

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